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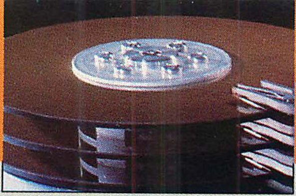

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TECH PC JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS

EXTENDED EDITION

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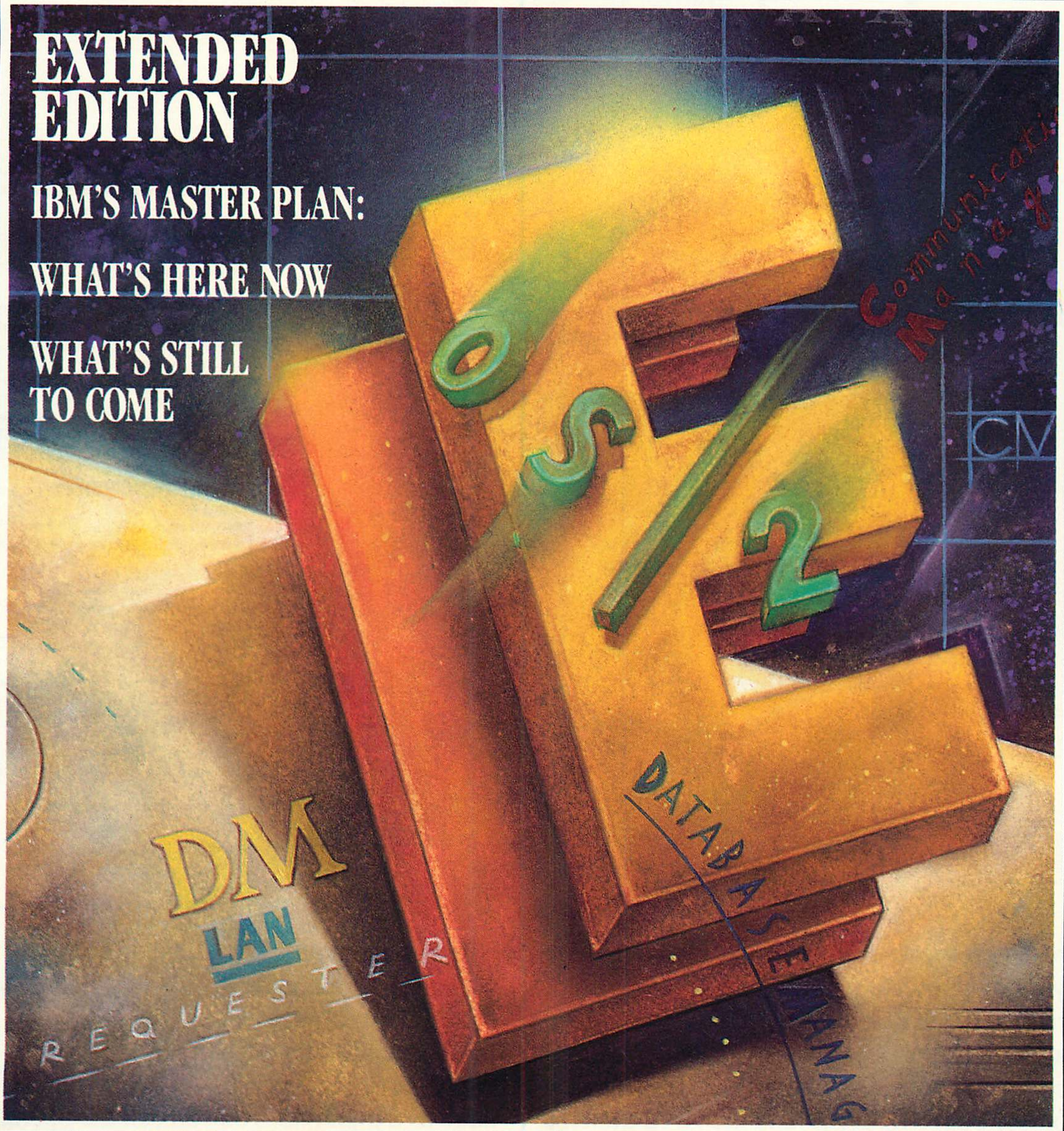

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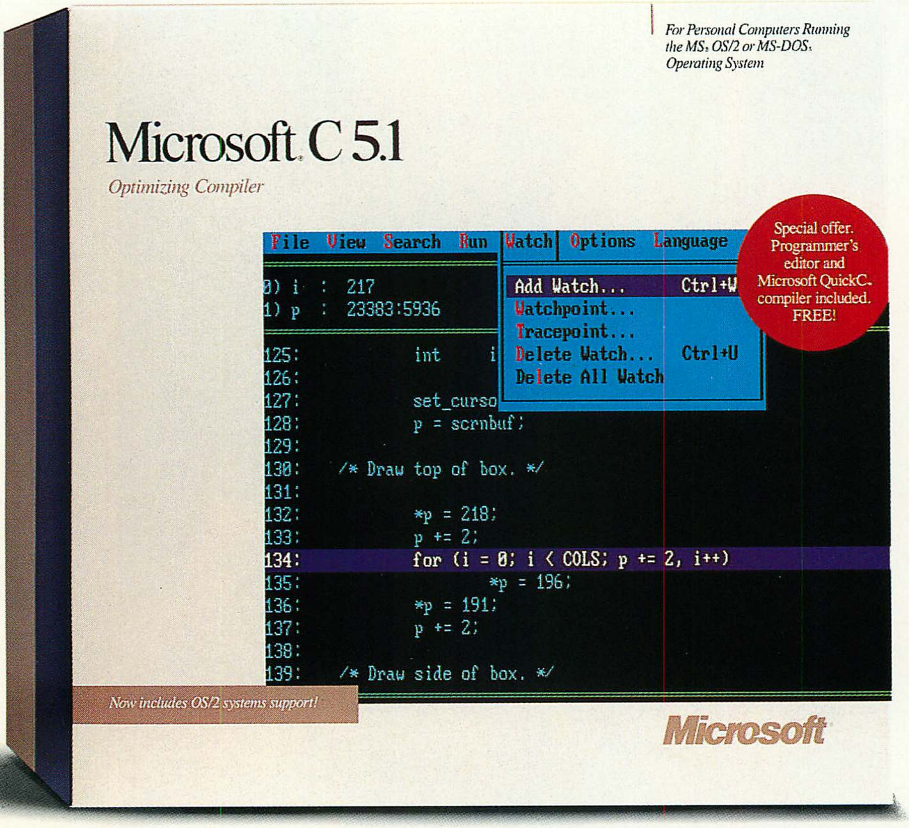


Microsoft C Optimizing Compiler 5.1 Techbox

Compiler
- Optimizations that generate the fastest code for DOS and OS/2 systems.
  - In-line code generation.
  - Loop optimizations.
  - Elimination of common subexpressions.
- Full OS/2-system support to break the 640K barrier. New.
  - Family API programs that run under DOS and the OS/2 systems. New.
  - Write multithreaded programs and Dynamic Link Libraries. New.
- Small, medium, compact, large, and huge memory models.
- Mix models with NEAR, FAR, and HUGE keywords.
- Fast compilation (10,000 lines/minute) with Microsoft QuickC.™
- Fastest math, in-line 8087/80287 instructions, and floating-point calls.
- More complete support of proposed ANSI standard.
- Over 350 library functions, including a graphics library.

Microsoft CodeView
- Full OS/2 systems support. New.
  - Debug applications of up to 128 MB under the OS/2 systems. New.
  - Debug multithreaded programs and Dynamic Link Libraries. New.
- Source-level debugging for precise control over programs.
  - Dynamic breakpoints in the source.
  - Debug programs written in a variety of Microsoft languages. New.
  - Full symbolic display of C structures. New.
  - Interactively follow linked lists and nested structures. New.
  - Watch variables, memory, registers, and flags.

Other Utilities
- Fast linking (twice as fast as the C 4.0 version linker).
- OS/2 incremental linker – up to 20 times faster than a full link. New.
- OS/2- and MS-DOS reconfigurable programmer's editor. New.

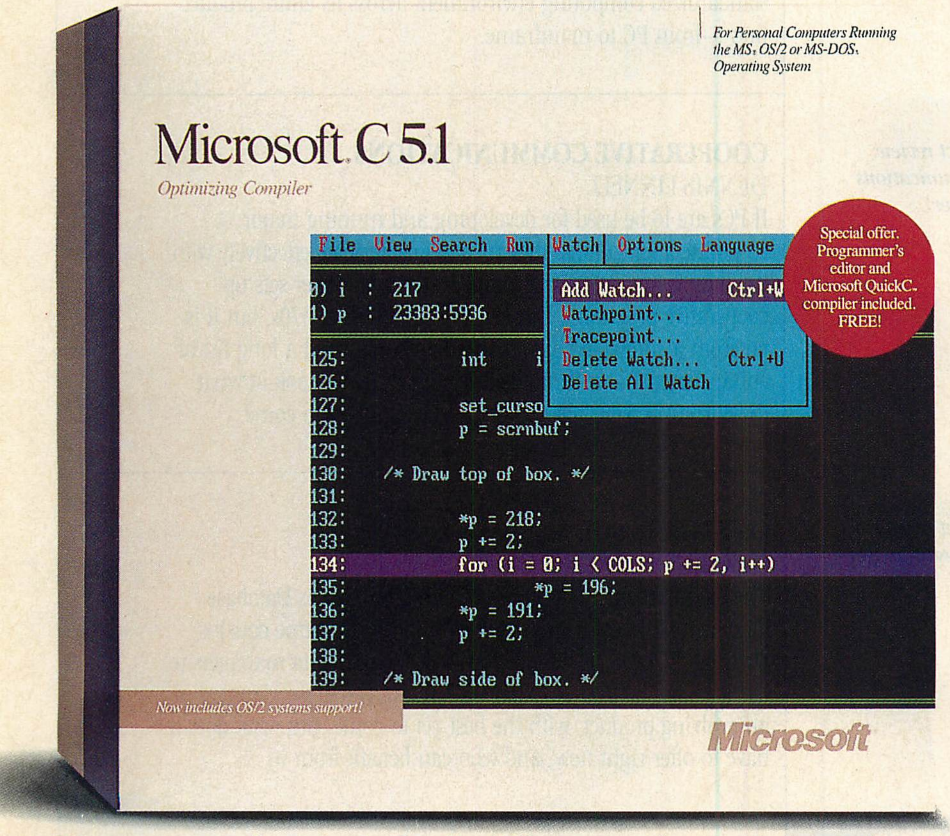
Everything about Microsoft® C Optimizing Compiler version 5.1 is dedicated to the professional programmer.

Fast code. Fast development. Fast debugging. And full support for both MS-DOS® and the OS/2 systems in a single package.

There's no faster C code on a PC, because powerful optimizations, such as in-line code generation and loop enregistering, generate executables that are compact and efficient. The documentation even teaches you special coding techniques to squeeze every last bit of speed out of your code.

Fast code isn't all you get. Under MS® OS/2, the 640K barrier is gone so you can write C programs as large as a gigabyte. You can call the operating system directly. Create more responsive programs (multiple threads allow program operations to overlap). And build Dynamic Link Libraries (DLLs) that can be shared, saving valuable memory. DLLs also allow your main programs to be smaller, so they load faster.

Introducing the fastest possible way to create the fastest MS OS/2 programs possible.



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Microsoft CodeView® is the highly acclaimed window-oriented source-level debugger that makes debugging fast and efficient. You can view program execution while you watch variables and register values change. And under MS OS/2 you can debug multithreaded applications, DLLs, and programs as large as 128 MB.

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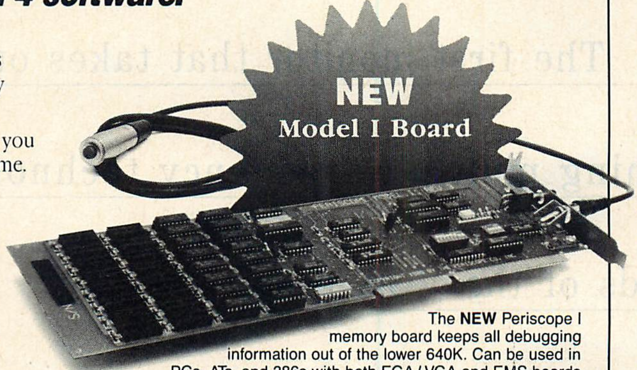
You No Longer Have to Share the Lower 640K With Your Debugger

Periscope I's new board uses ZERO memory in the lower 640K. Yet it has plenty of room to safely store all debugging information, like symbols, as well as the powerful Version 4 software.

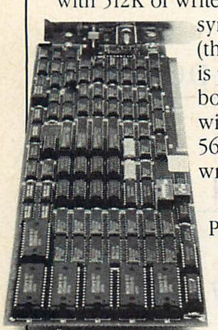
Periscope's hardware adds the power to solve the really tough debugging problems.

The break-out switch lets you break into the system any time. You can track down a bug instantly, or just check what's going on, without having to reboot or power down and back up. That's really useful when your system hangs! The switch is included with Periscope I, Periscope II, and Periscope III.



The **NEW** Periscope I memory board keeps all debugging information out of the lower 640K. Can be used in PCs, ATs, and 386s with both EGA / VGA and EMS boards installed. The Periscope break-out switch enables you to recover from a hung system. Included with Models I, II, and III.

Periscope I has a **NEW** board with 512K of write-protected RAM, user-expandable to 1MB, for the Periscope software, symbol tables, and all related debugging information. Normal DOS memory (the lower 640K) is thus totally freed up for your application, and Periscope is protected from being overwritten by a run-away program. The new board's footprint is only 32K, so you can use it in PC, AT, and 386 systems with EGA/VGA and EMS boards installed (not possible with the previous 56K board). It can also be used with Periscope III to provide additional write-protected memory.



Periscope III has a board with 64K of write-protected RAM to store the Periscope software and as much additional information as will fit. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!

The Periscope III hardware-breakpoint board captures information in real-time, so you'll find bugs that can't be found with a software-based debugger.

Periscope's software is solid, comprehensive, and flexible.

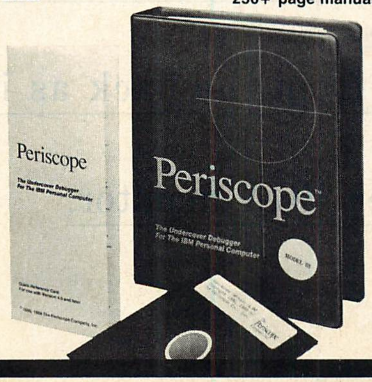
It helps you debug just about any kind of program you can write... thoroughly and efficiently.

Periscope's the answer for debugging device-drivers, memory-resident, non-DOS, and interrupt-driven programs. Periscope works with any language, and provides source and/or symbol support for programs written in high-level languages and assembler.

David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source-level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope industry standard for debugg

Periscope software & 250+ page manual



What's New in Periscope Version 4:

- View local symbols from Microsoft C (Version 5)
- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source-level support
- Monitor variables in a Watch window
- 80386 debug register support
- Debug using a dumb terminal
- PS/2 watchdog timer support
- Use mixed-case symbols
- Set breakpoints on values of Flags
- Much more!

- **Periscope I** includes a **NEW** full-length board with 512K of write-protected RAM; (user-expandable to 1MB); break-out switch; software and manual for $795.
- **Periscope II** includes break-out switch; software and manual for $175.
- **Periscope II-X** includes software and manual (no hardware) for $145.
- **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 10 MHz with one wait-state is $1395. Plus the new Model I board, $1995.

Due to the volatility of RAM costs, prices on board models are subject to change without notice.

REQUIREMENTS: IBM PC, XT, AT, PS/2, 80386 or close compatible (Periscope III requires hardware as well as software compatibility, thus will not work on PS/2 or 80386 systems); DOS 2.0 or later; 64K available memory (128K at installation time); one disk drive; an 80-column monitor.

Call us with your questions. We'll be happy to send you free information or help you decide on the model that best fits your needs.

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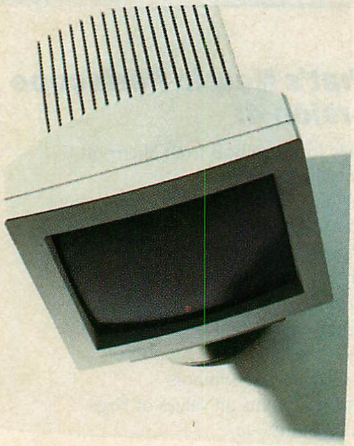

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The first monitor that takes our award-winning multiple frequency technology and customizes it to the needs of the VGA user.

MultiSync 2A is both affordable and uncompromised. And completely compatible with all VGA modes. In short, it performs brilliantly. But what's equally important, it allows you to move effortlessly to the next major graphics standard: SuperVGA.

All this in a monitor that gives you a 14″ non-glare screen on a tilt-swivel base, for nearly 30% more viewing area than standard 12″ screens, and a new cabinet that's not only functional but is designed to look as good from the back as it does from the front.

MultiSync 2A. One super VGA monitor.

VGA mode shown at 320 X 200

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XQL Relational Primitive Operations. In addition, XQL lets you bypass the SQL level and perform highly efficient, relational primitive operations directly. You get all the functionality of a relational database model without the constraints of a 4th generation language.

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Like Btrieve, XQL offers features like multi-user support, fault tolerance, comprehensive documentation, and expert technical support. And you never pay royalties on your XQL applications.

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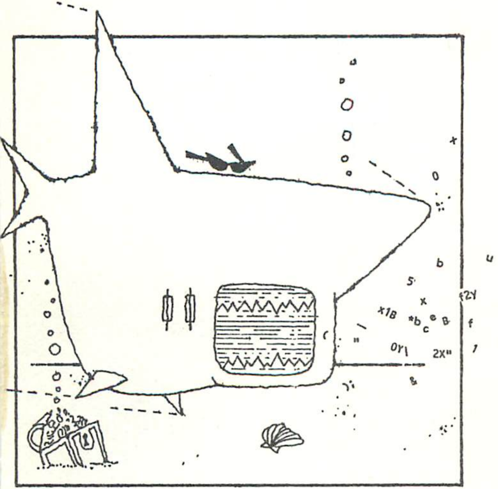

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SYSTEMS PERSPECTIVE

J. Anderson

Reader Expertise

This is who you are, and this is what you know. We turn to you for your expertise.

Month after month, *PC Tech Journal* recommends products for you, the systems developer. You have come to trust us to understand the problems you face in your job, to anticipate your questions, and to deliver the answers you need.

PC Tech Journal is able to deliver that expertise because the background of our editorial staff closely parallels the background of our readers. No other magazine has such a technically sophisticated and computer-knowledgeable staff, but then no other magazine has such a technically sophisticated and computer-knowledgeable readership. Recognizing your expertise and practical experience, the editorial staff decided to turn to you, the systems developer, for product recommendations.

Our November 1988 reader opinion card asked readers to nominate the best products in six different categories: development tools, data managers, computer systems, communications, multitasking operating environments, and add-in boards. The response was heartening; more than 200 products were nominated.

Of those, our electoral college (consisting of executive editors Susan Holly and David Methvin, Professional Viewpoint author Jordene Zeimetz, and myself) selected the 27 most notable products to honor with our Professional Solutions Award. We present the honorees this month in a special two-page Professional Viewpoint that begins on page 160.

Our goal was not merely to count votes and declare the winners. After all, the most popular products are not always the best products. Sometimes, a product is used because it's there; because it is on the corporate list of acceptable products; or because developers are already trained in its use.

Instead, we looked at the *reasons* you gave for your vote. For a product to win a Professional Solutions Award, it has to have provided a real service to you or solved a practical problem.

An underlying theme for endorsing development tools and data managers is increased productivity. Time savers and money earners rank highest among our readers. One consultant, who for obvious reasons I will not name, recommends a product because he could "work for six hours and bill for eight." Hardware products are valued for reliability, compatibility and performance, and the comfort of knowing service and support are available.

SYSTEMS DEVELOPER WHO?

The purpose of Professional Viewpoint is to give you a chance to communicate with other systems developers who are facing similar problems and to share your answers—such as what products have worked for you.

Just who are your fellow systems developers? For an answer, I turn to a study our research department just completed on the systems-development activities of our audience. The results tell us who you are, what you do, and how you use your computer.

First, what type of computers do you and your companies use? Eighty-six percent of your organizations have 8086/88 machines. As you might expect, this number is down eight percent from a similar study we conducted 18 months earlier. One-fourth of you report having one of these 8086/88 machines installed on your desk.

For the 80286, the story is brighter. The number of companies with 286s now matches that of 8086/88s. This number has grown by as many percentage points as the base of 8086/88 machines has fallen. Half of you have a 286 on your desk.

The real dramatic growth, however, is in 80386 machines, which are now installed in more than half of your companies, up from only 12 percent in our last study. Yet, less than 20 percent of you are lucky enough to have a 386 for your desktop. Despite the dearth of memory chips last year, more than half of the machines you use in your work—all processors combined—have more than 640KB.

The PCs you use are not isolated entities. Two-thirds of them are connected to other PCs. In half your installations, PCs are linked to mainframes; the same number are connected to minicomputers. Three-fourths of you are involved with selecting, installing, and maintaining these links.

With computers installed throughout your organizations, it is not surpris-

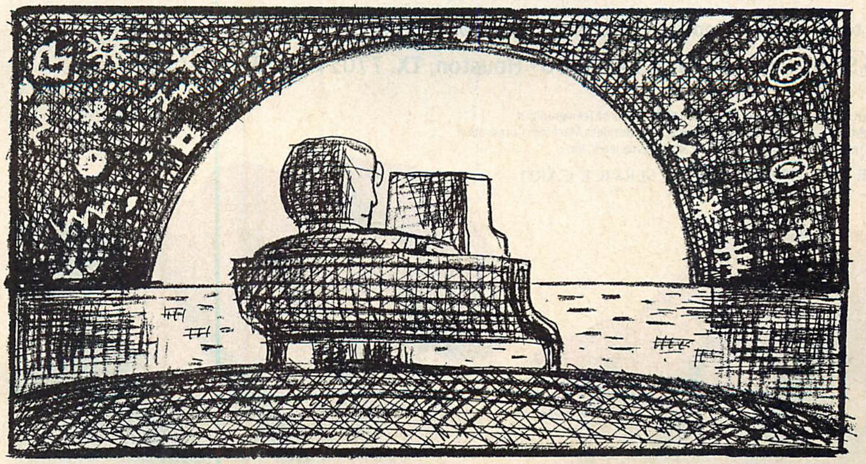


ILLUSTRATION • MACIEK ALBRECHT

ing that you spend a full 65 percent of your time in computer-related activities. This includes acquisition and integration, as well as applications development from design to implementation to end-user support.

For an applications development language, you are most likely to turn to C or BASIC, with these choices followed closely by assembly language. One-third choose Pascal; COBOL and FORTRAN have a respectable, if not overwhelming, following.

Consistent with your penchant for productivity, you are just as likely to turn to an applications development environment as you are to a programming language. More than 60 percent use a data manager, and almost half develop custom applications using a spreadsheet macro language. Also popular are communications script languages and other embedded languages in off-the-shelf packages.

How are you able to manage this tall order as systems developers and integrators? Almost every one of you has formal computer training (one-third have a degree in computer science or a related field) and several years of experience. You have been working with microcomputers since before the IBM PC was introduced. You have an average of six-and-one-half years' experience on minicomputers and almost nine years' experience on mainframes.

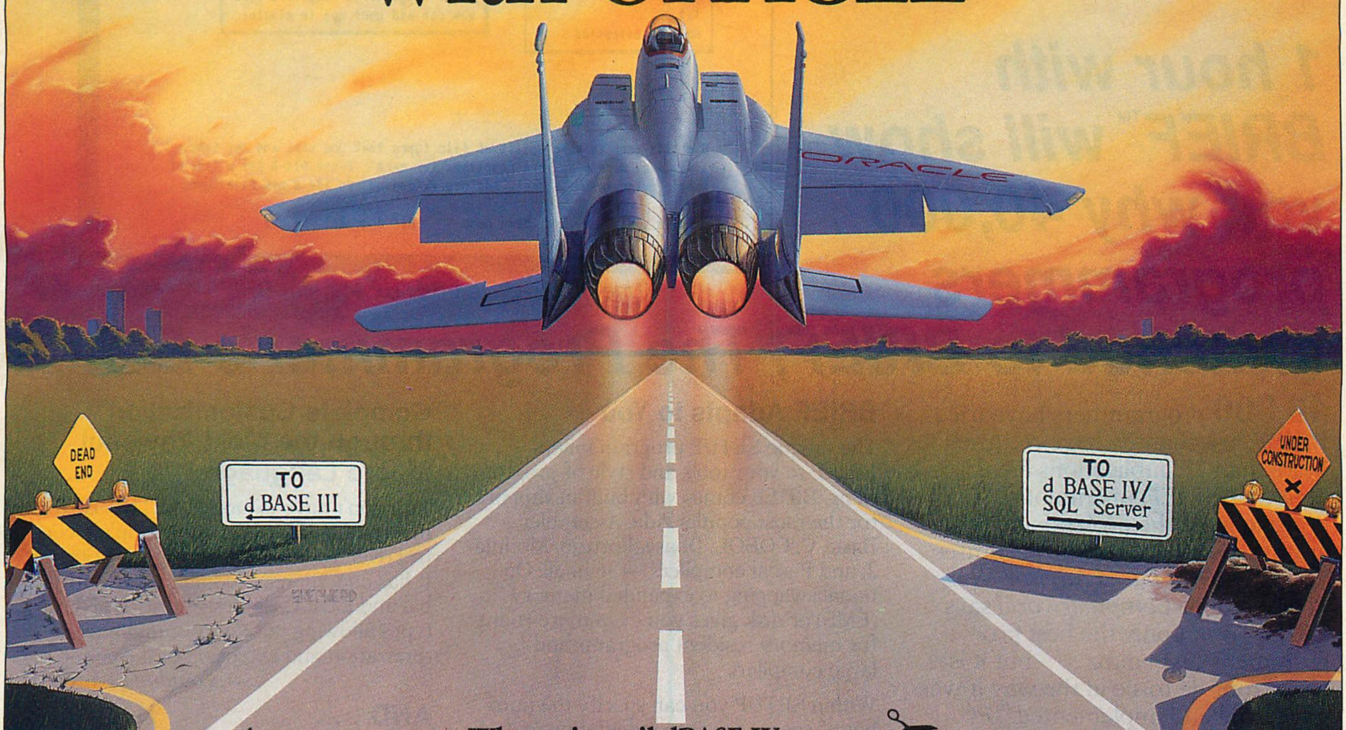
IN THIS ISSUE

For those of you who must connect PCs to IBM mainframes, we have compiled this month's cover suite on OS/2 Extended Edition, the first piece of IBM's Systems Application Architecture (SAA). Although all the elements of SAA are far from being in place, we give you a look at what parts are here now and what is still to be delivered.

Dennis Linnell looks to the rosy future IBM promises in "The OS/2 Puzzle Takes Shape" (p. 44). Linnell examines the Communications Manager portion of Extended Edition in "Cooperative Communications" (p. 52), and Herb Edelstein looks at DataBase Manager in "OS/2 Meets SQL" (p. 62).

Unfortunately, many of the essential elements that will make IBM's rosy forecast come true do not yet exist, nor has IBM announced delivery dates for them. The decision to go with Extended Edition is one that can only be made with an eye to the future, and with the hope that IBM will eventually deliver on its promises.

Get out of the danger zone with ORACLE®



Announcing ORACLE Quicksilver

All the database Top Guns are flying SQL, the industry-standard data management language first delivered by Oracle. Now, ORACLE Quicksilver adds SQL and connectivity to your dBASE applications, so you can fly them into the 1990s.

Your ticket to the future

ORACLE Quicksilver is a compiler that turns your dBASE programs into fast, secure, multi-user applications that can access both distributed ORACLE and dBASE data. It delivers all the capabilities of dBASE, plus powerful extensions like windowing, graphics and user-defined functions. You can even add SQL statements to your dBASE programs for more powerful, flexible data access.

ORACLE database included

ORACLE Quicksilver comes with the ORACLE RDBMS. So you can get automatic indexing, comprehensive security, and mainframe-class data integrity.

Why wait until dBASE IV can talk to SQL Server?

dBASE IV doesn't talk to SQL Server yet. When it finally does, it will only talk to SQL Server on OS/2—not on any other operating system. Which means you'll still be isolated from corporate data on minis and mainframes.

Add connectivity to your dBASE applications today

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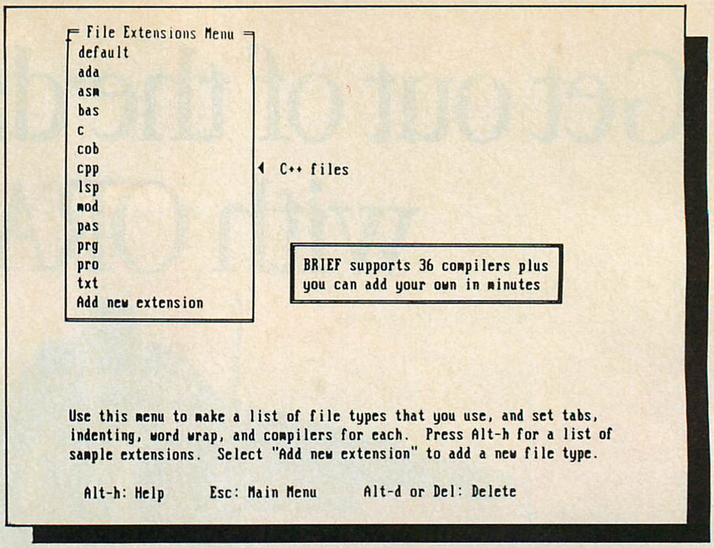

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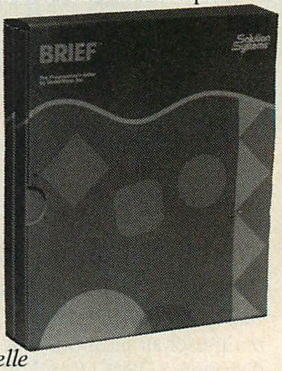

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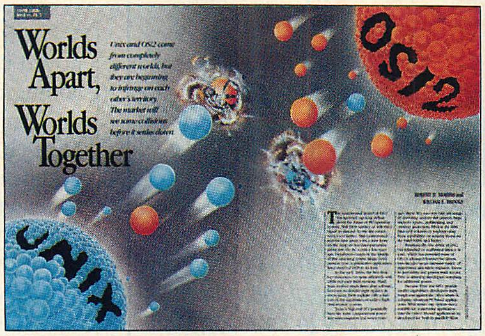

WHEN WORLDS COLLIDE

Because I have a great interest in both OS/2 and Unix (as well as other platforms), I read with eagerness the articles in your December 1988 cover suite, Unix versus OS/2 ("Worlds Apart, Worlds Together" and "At the Core: An API Comparison," Robert R. Morris and William E. Brooks, pp. 50 and 62). Although the authors make many valid points, I am concerned with what I perceived in the articles to be a bias inherent whenever someone who is experienced in one system attempts to compare it with a new system. My own bias is toward Multics—an ancestor of both Unix and OS/2 developed jointly in the mid-1960s by MIT and GE (now Honeywell). Between the two more recent systems, I have done more programming in OS/2 than Unix.

It is also difficult to evaluate two systems in transition. The definition of Unix is still being settled upon (and fought over). This is especially true in the area of windowing systems. In OS/2, the windowing system is more stable, but many of the applications facilities that users expect are not yet available; the networking programs are just being delivered and the file system needs (and will get) a rewrite.

In comparing platforms, we must be clear as to our audience. A user writing a simple program in C would see little of the fundamental differences between the two systems, while the developer producing an application with intended (hopeful?) sales in the millions would take a very different view of which system facilities to exploit. The end user (or developer acting as a user) is a third audience.

For this last group, I would argue that neither Unix nor OS/2 currently provides adequate facilities in the manner to which we are accustomed for both DOS and the Macintosh. I do expect these products to become available as soon as developers make their choice of which platform to program for or on how to support multiple platforms in their products.

As we pass through a transition from limited single-application systems to more complex environments, much learning is needed and some dislocation will take place. A serious developer needs to have a deep understanding of each system in order to exploit it fully. Dismissing capabilities because they are misunderstood after a first, quick reading does not provide the reader with a basis for making long-term decisions.

I have some comments regarding specific points made in both articles and wish to address them by topic.

80286 versus 80386. Yes, I will agree that the 386 is a much better processor, and I am annoyed that OS/2 does not yet allow me to exploit the 386 fully. The 386 provides not only larger segments, but also higher-performance, 32-bit operations. I expect that OS/2 will allow use of these 386 capabilities within the next year or two.

Indeed, 64KB segments are too small. The 386 supports *multiple* 4GB paged segments that provide a much better basis for address-space management and memory management, which are two very different issues. I do not have room to give a full discussion on the value of a two-dimensional address space (multiple independently named objects) except to observe that a Unix user must take a guess as to the maximum size of each object and cannot afford to let each have a limit of 4GB. The user sees this as both a loss of efficiency and a set of arbitrary limits in applications.

To put it more briefly, if one 4GB segment (linear model) is great, why not allow a few thousand? The 64KB limit shows up only when attempting to allocate single large objects. As noted in the second article, some of the compilers generate extra code in an attempt to hide this from the user. Mainly, just making free use of **malloc** for objects under 64KB makes the segmentation transparent.

Of course, one should use 32-bit pointers (large model, 16:16 segment:offset) as the default in order to hide much of this complexity. When used in most applications, a large model costs little in terms of performance and greatly simplifies the development of applications.

The use of explicit **near** and **far** is only necessary for the advanced user who is fine-tuning performance.

Dynamic link libraries. DLLs are actually very simple to use in OS/2. When using them, I have a few suggestions:

- When compiling, use the -ALu model. This causes the pointer to the data segment to be loaded on procedure entry. This model has very little overhead and allows programs to be called from outside their own module.
- Create a .DEF file that lists the entry points to be exported, as in:

```
LIBRARY   UTIL2
DESCRIPTION 'Utilities Library'
PROTMODE
EXPORTS
   UTILITY_FUNCTION1
      _utility_print
```

- Use IMPLIB, as in:

```
implib util2.lib util2.def
```

- One caveat: global variables are not automatically shared between DLLs.

I do expect the documentation provided by both Microsoft and IBM to improve and be supplemented by independently written books.

OS/2 facilities. It is noted that many facilities in OS/2 are not part of the kernel, but are implemented in DLLs. This is one of the great strengths of OS/2. The system facilities can be extended by third-party and manufacturer-supplied subsystems without having to modify the kernel of the system.

On the other hand, I, too, am annoyed by the difficulty of dynamically adding device drivers to OS/2. Actually, one can add drivers as I/O privilege level (IOPL) programs as long as they do not need to use interrupt facilities.

Communications and networks. Comparing communications and LAN facilities between OS/2 and Unix is difficult. The OS/2 LAN Manager, Extended Edition LAN, and Systems Network Architecture (SNA) facilities are just becoming available. Novell also has its NetWare products. I expect transport control protocol/internet protocol (TCP/IP) and Sun Microsystems' Network File System (NFS) to become available for OS/2.

Unix TCP/IP and NFS capabilities are widely available from third parties and are not an intrinsic part of Unix, even though some vendors do make it a part of their standard offering. Unix mainframe connection programs are also available from third parties.

Incidently, named pipes are now a part of OS/2 Standard Edition 1.1 as well as Extended Edition 1.1.

I feel that the next generations of programs need at least to have the capabilities provided by complex systems such as OS/2 and Unix in order to make powerful applications simple for the end user. Both systems offer unique advantages, but in fully exploiting systems, we must be aware of their unique advantages.

Robert Frankston
Lotus Development Corporation
Cambridge, MA

EISA, YOU'RE NO MCA

Thanks for the excellent column that compared the Compaq-led consortium's Extended Industry Standard Architecture (EISA) with IBM's Micro Channel architecture ("EISA: A Mistake," New Directions, Will Fastie, December 1988, p. 21). As recently as the *PC Tech Journal* Systems Forum '88 held in San Francisco last June, my defense of the Micro Channel was a very unpopular position. I was something of a lone voice in the wilderness.

My frustrations with the Micro Channel have never been the result of engineering specifications, merely IBM's marketing position. I think IBM shot itself in the foot when it closed the architecture and, ultimately, hurt the whole PC industry.

The two major results were a fragmentation of the 32-bit standard (at my last count, five or six major contenders) and, more to the point, the dearth of 32-bit boards. Where are the fast,

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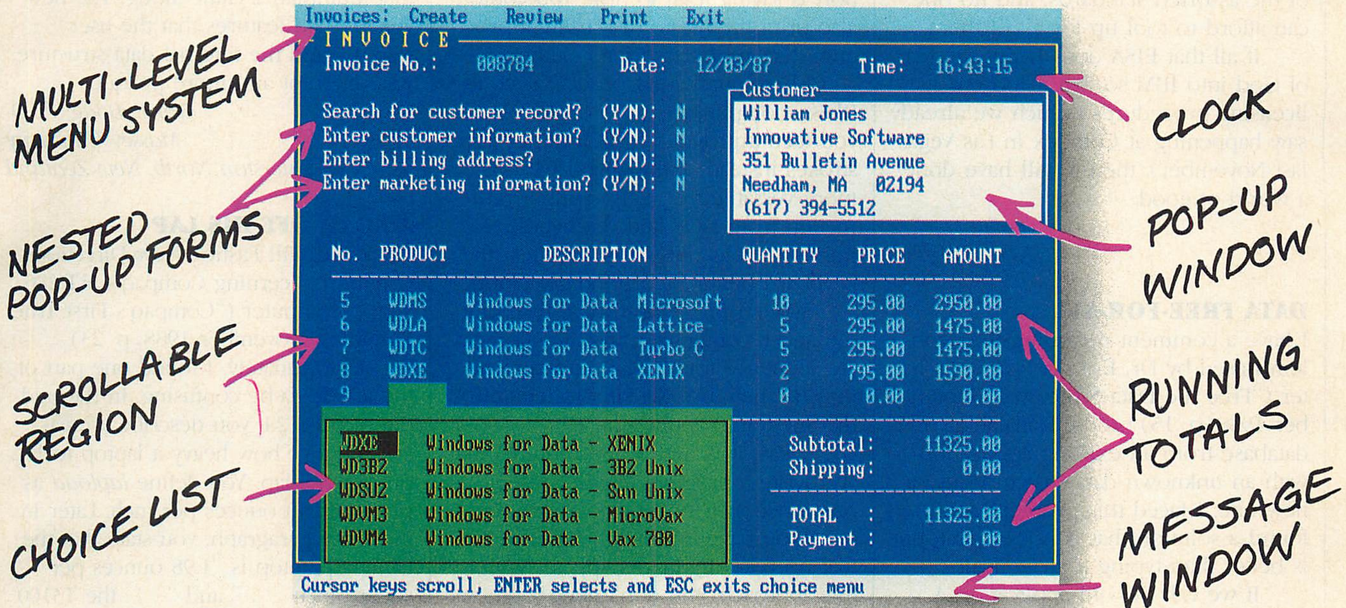

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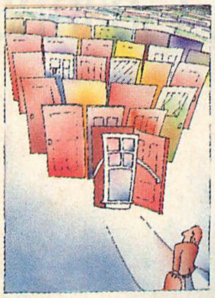

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smart, 32-bit communications cards; the super-fast video adapters; the hardware debuggers; and so on?

Clearly, no manufacturer is going to bet his business on backing any one of the assorted standards, and no one can afford to tool up for all of them.

If all that EISA does is put the fear of God into IBM so that it loosens its licensing procedures (which we already saw happening at Comdex in Las Vegas last November), then it will have done a world of good.

Leslie Fiering
New York, NY

DATA FREE-FOR-ALL

I have a comment regarding the problem raised by Dr. Evan P. Provisor's letter ("Free the Data Structure," September 1988, p. 15) on the translation of a database from an existing application with an unknown data structure into a new one. I faced this problem and found a solution that is not elegant, but is better than typing it all in again.

If we call the old application *A* and the new one *B*, the first thing to do is to print out all the data in *A* and capture them on a disk just as printed. Various methods are available to do this—one simple method is to redirect the printer to a COM port and attach a second PC running any standard communications software instead of a printer. Application *A* thinks it is printing the stuff, and the PC on the COM port is saving it all to disk. You could also print the file to disk using a program that redirects printer output.

Then, purchase a product such as Blaise Computing's KeyPilot. This lets you feed a program from a file of keystrokes instead of the keyboard. It is more versatile than simple input redirection from DOS and can handle quirks such as programs that flush the keyboard buffer before the next input.

Write a program to read the print file and reconfigure it into an appropriate sequence for feeding into application *B*. Then, use KeyPilot to feed all this mess into application *B*.

Okay, it is untidy and requires that you write a program that gets used only once. It is bulletproof, however, once you have it right, and it ensures that no rekeying errors appear. With this approach, you don't need to know anything about the internal data structure of either application.

Incidently, I agree fully with all the comments about how nice it would be if data structures were made available. I once spent several days figuring out how data were stored in Microsoft Multiplan version 1, so I could write a routine to consolidate spreadsheets. It worked, too—the only problem was that Multiplan 2 came along. The new version had features that the user wanted, and the internal data structure was different and more opaque.

Ian F. Boag, Ph.D.
Massey University
Palmerston North, New Zealand

A LOAD OFF HIS LAP

I enjoyed Will Fastie's New Directions column concerning Compaq's SLT/286 laptop computer ("Compaq's First True Portable," November 1988, p. 23).

Unfortunately, I found one part of the article to be confusing. In the middle of page 24, you describe a measurement of how heavy a laptop feels on a user's lap. You define *lapload* as measured in ounces per inch. Later in the same paragraph, you state that the Compaq laptop is "1.98 ounces per square inch . . . " and " . . . the T3100 at 1.4 ounces."

I believe you are simply describing how much pressure a laptop will exert on a user's lap. Pressure is usually defined in terms of weight divided

by a surface area that comes in contact with a user's lap. This measurement, in your case, would be in units of ounces per square inch, not ounces per inch as stated in the article.

Thomas P. Black, manager
Arthur Andersen & Company
Boston, MA

You are absolutely correct. Ounces per square *inch is obviously what I meant. I regret the error.* —*WF*

TO BASH, OR NOT TO BASH

In response to Will Fastie's comments on the recent MacWorld Expo in his November 1988 column (New Directions, p. 30), I would like to tender my own opinion.

First, allow me to express my bias by saying that I work in a PC environment during the day and then return home to my Macintosh system by night. Now, quoting Mr. Fastie:

> If I had to answer the question, "What was the most significant trend you observed at MacWorld?," I would answer by saying that anything—literally anything—that was *new* attracted big crowds, while the established products received less attention. This, in combination with my other observation, convinces me that Macintosh lives in an immature market, one not quite ready to do corporate business.

How narrow-minded! If I were to attend a PC Expo, I would do the same thing. Since I know what established products can do (that is, if I've done my job as a computer systems manager), why visit these booths? I need to know what is new so I can increase my productivity. Realizing your bias as the editorial director of a PC-oriented magazine, however, I can understand your need to do some Mac bashing to protect your career and livelihood.

Dana V. Eales
Ohio Edison
Akron, Ohio

If you look at what I have written in past columns, you will find that I have long been a supporter of Macintosh (for example, see "Mac II Attack," New Directions, June 1987, p. 9). I still am; I recommend the system to many who ask for advice, and I was instrumental in the decision to bring Macintosh into PC Tech Journal*'s lab. Those asking my advice, however, are individuals, people in small businesses, or those needing solutions for the graphic arts. Corporate America is less interested.*

The corporate customer says, "Here's my problem, now let me look for a solution." The Macintosh simply lacks too many important requirements—such as good data management or serious connectivity solutions—for that customer. That is not Mac bashing; it is the simple truth.

Projections from numerous independent research organizations confirm that the market for business PCs is about ten times bigger than the Mac market today; that ratio will hold for at least the next five years. During that time, the PC side of the world will catch up with Mac's graphics and ease of use. My own prediction is that this will happen quickly, within the next year, in fact. Will Apple and its third-party developers be able to catch up with the things that are important to American business? —*WF*

LESS OF MEMORY

I would like to respond to your review of Direct Technology's Automator mi (Product Watch, Paul Firgens, December 1988, p. 123). Although I appreciated the review's concise description of Automator's concept and function, I would like to correct and clarify some points made in the review.

The article stated that Automator's development package uses almost 276KB of memory and that the runtime module "consumes another 84KB of memory before the pseudocode is included." This statement incorrectly declares that the runtime interpreter uses a total of 360KB of RAM.

As a matter of fact, Automator's runtime interpreter uses only 84KB of memory including the written code, regardless of the size of the program written. As I am sure you would agree, the difference between 360KB and 84KB is great. This clarification might lead some readers to contest Mr. Firgens's opinion that Automator "is costly in PC memory."

I would also like to clarify an additional point. Although it is true that Automator (along with several other TSRs) will not run with the IBM 3270 Workstation Control Program, it does drive a wide range of other IBM 3270 emulation products, including IBM 3270 Emulation Program versions 1.0, 2.0, 3.0, and patches.

Nadia Garber, manager
Direct Technology
New York, NY

The implication that the runtime interpreter requires more than 84KB is incorrect. PC Tech Journal *regrets any confusion this may have caused.* —*JS*

ERRATA

In Alan C. Wu's article, "Bright Lights, Fast LANs" (November 1988, p. 96), the last sentence on page 100 should read, "This feature allows two *frames* to be on the network at one time . . . ." On page 106 of the same article, two references to DME (for differential Manchester encoding) should have read simply Manchester encoding. *PC Tech Journal* regrets the errors.

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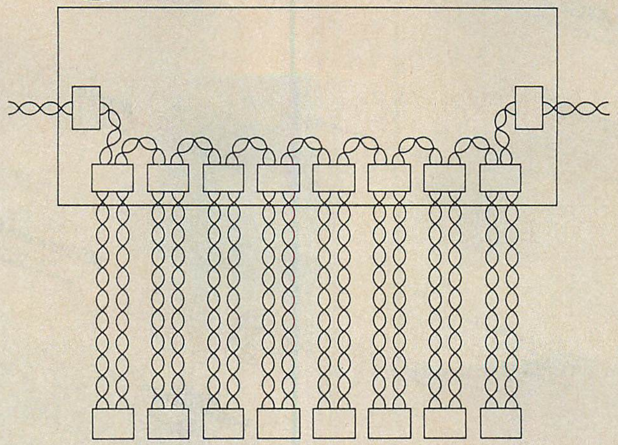

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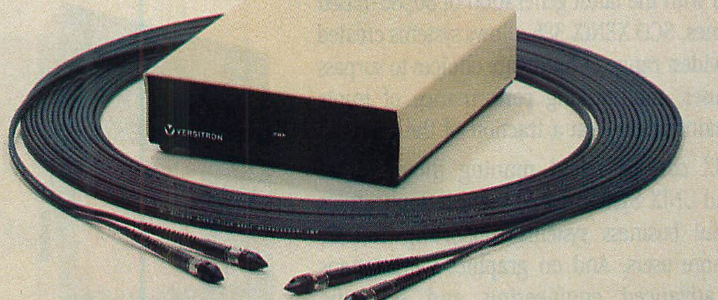

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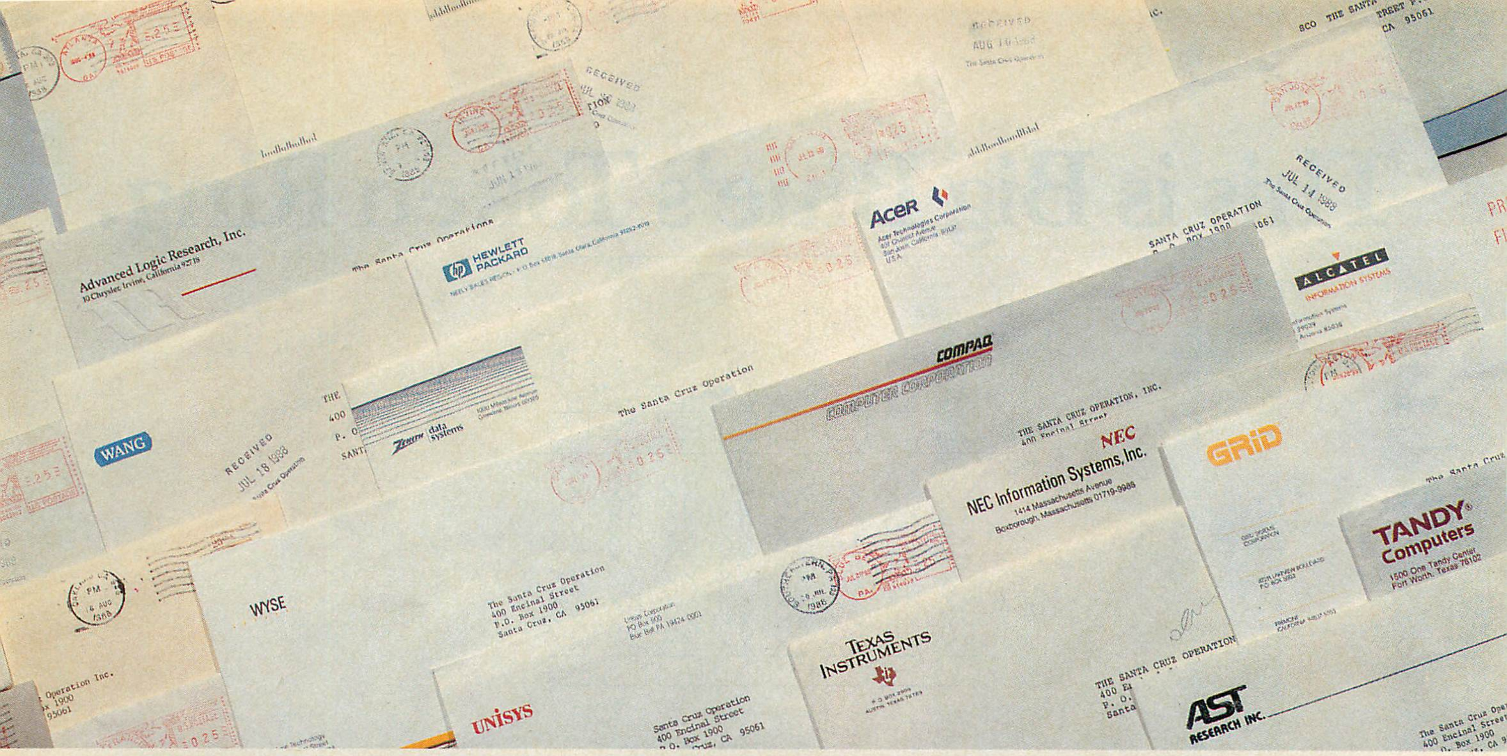

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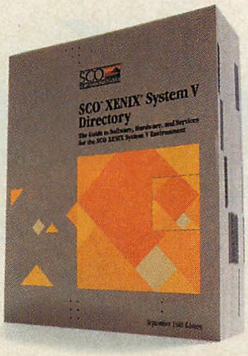

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Paradox 3.0 takes the popular data manager to new heights. □ *Also, Emerald Bay, QB 4.5, ink-jet printers, Above Boards, Windows on video.*

Paradox 3.0 has arrived, and although it does not yet include the Structured Query Language (SQL) extension, Borland's latest data manager represents an important advance for a product that is showing real signs of strength and growth in the market. Borland has promised SQL connectivity by mid-year.

The new version of Paradox embodies changes in a number of areas. Paradox's developers have extended the now-famous Query-by-Example (QBE) facility to make it even more expressive; support for graphics and EMS 4.0 has been added; the addition of multitable forms and reports has improved the relational system; a hard disk is now required; and the Paradox Applications Language (PAL) supports all the new features.

BETTER QUERIES

The QBE facility of Paradox, from which much of the power of the product stems, is its most important characteristic. Any improvements made to QBE must therefore be the primary focus of attention.

The most significant addition to QBE is a capability known as outer join. Paradox already supports inner joins, so it now becomes one of the few data managers to support both types. Most data managers support inner joins; when a query is made on two or more files, an inner join returns an answer table containing only those records for which a match was found.

An outer join, however, can produce records for the answer even if a match does not exist. This situation might arise, for example, if you wanted a list of the number of different products each of your customers had purchased, including those customers who had purchased nothing. An inner join excludes the latter because no match is found in the orders table, while an outer join returns a record for every customer and simply leaves the count field blank as appropriate.

An outer join is designated by the use of an exclamation point in the linking field of the Paradox query form. Multiple fields may be so designated. As with all Paradox queries, a bit of experimentation is often helpful to understand the concept, but the Paradox developer will quickly see the value of this new extension.

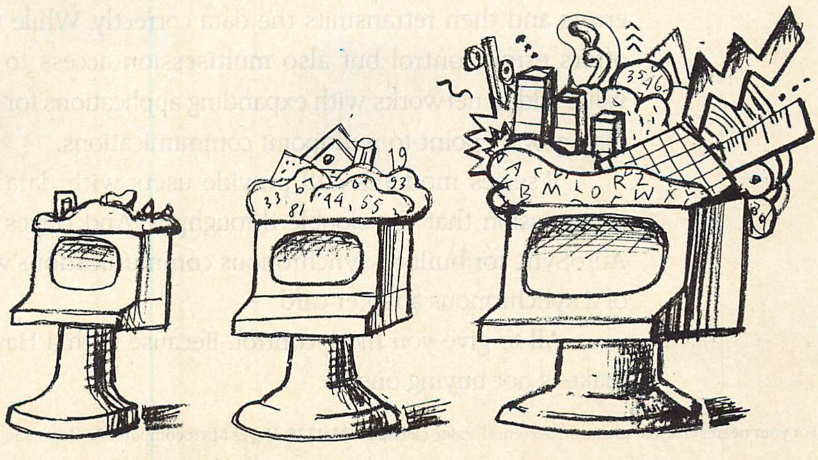
Another significant addition to QBE is the ability to perform operations on sets. You thus can do a comparison on a group of records, not just a single one. QBE is now able to express questions such as, "Which *PC Tech Journal* readers read no other computer publications?" or "Which hardware store customers bought only lamps?" or "How many magazine editors own exactly five television sets?" Using the SET key word in the leftmost column of the query form indicates which records should be placed in the set for comparison, while the ONLY, EXACTLY, EVERY, and NO key words are used in fields to qualify the answer.

QBE has two other new operators for query forms. The OR key word is a simplified existing feature. Previously, Paradox required a separate line for each OR condition. Now, the phrase NY OR MD OR MA in the state field could find all *PC Tech Journal* readers in New York, Maryland, and Massachusetts, a much more intuitive solution.

The other new operator, AS, can explicitly define a name for a column in the answer table. By default, Paradox uses the table's field names or, if the field is derived, creates a derivative name. Although this usually does not pose a problem for the user, it creates a subtle stumbling point for the Personal Programmer (PPROG), Paradox's application program generator, which previously limited the types of queries because of this naming problem. The addition of AS significantly extends the range of PPROG.

FAMILY GRAPHICS

The sexiest enhancement to Paradox is the addition of a complete graphics subsystem. In this endeavor, Paradox's developers took advantage of their Borland family affiliation by integrating the graphics engine of Borland's Quattro spreadsheet into Paradox. The Quattro engine is a solid one, with attractive fonts, good color and patterns, and strong performance. The integration into Paradox is clean; the user can obtain a graph by placing the cursor in a numeric data column and then press-



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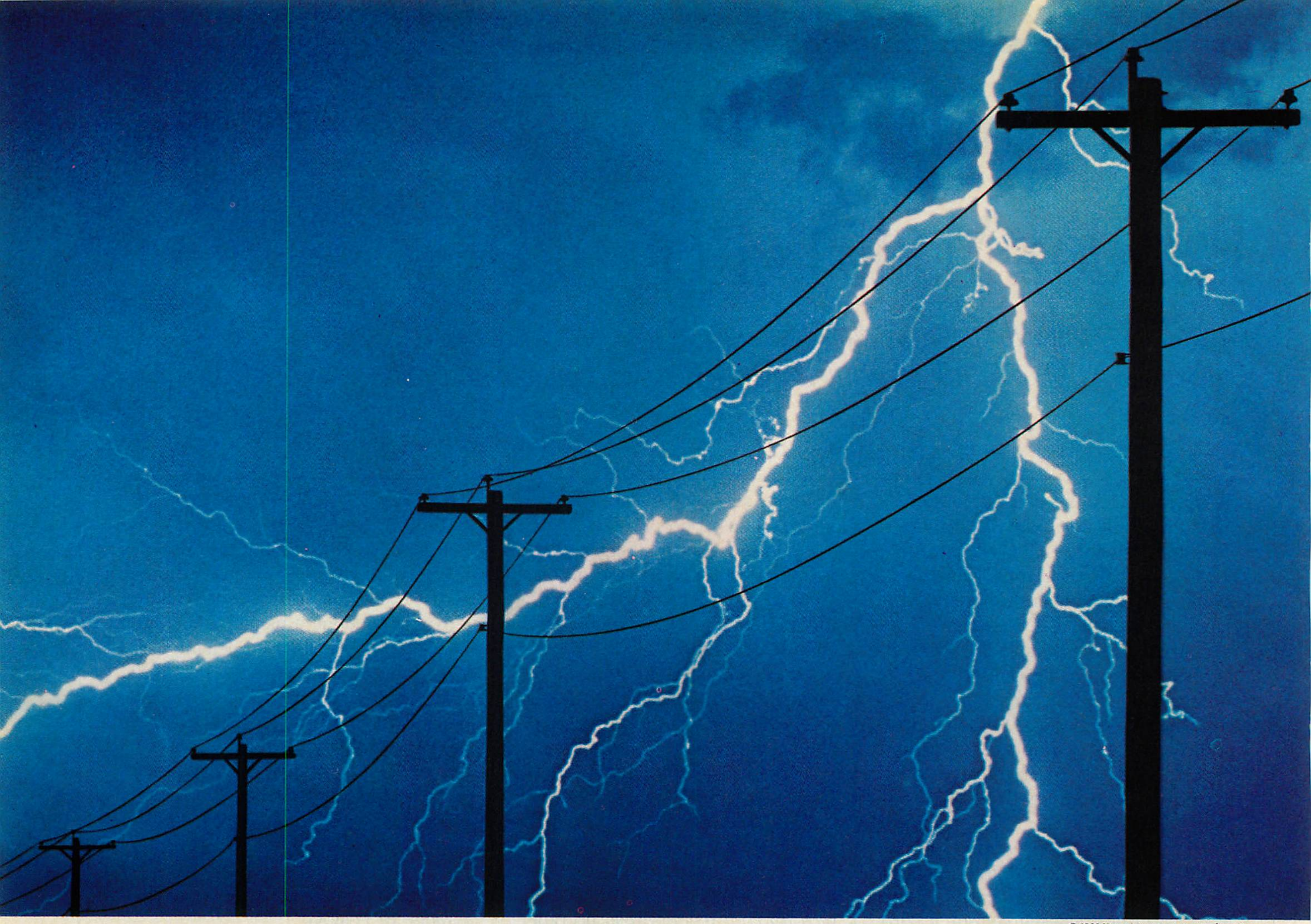

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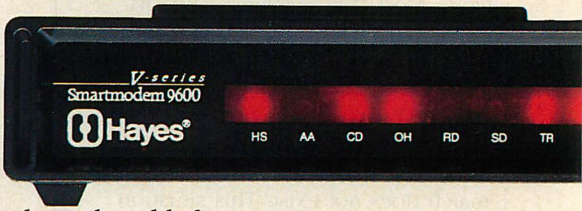

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ing a single key. The addition of graphics requires printer support, so Borland has included an extensive set of printer drivers.

The value of graphics in Paradox may not be immediately clear to someone unfamiliar with the product. Paradox is an excellent tool for statistical analysis because of the combination of QBE, a variety of numeric and statistical functions, and the tabular presentation of the data. The ability to put such data into graph form is extremely valuable to scientists, engineers, financial analysts, and many others. To make Paradox's graphing capabilities useful, Borland added the Crosstab operation to 3.0; it transforms normalized data into a form more suitable for graphing.

Of all the enhancements to Paradox, the new graphics feature will give it the biggest boost from a marketing perspective.

NEW RELATIONS

Paradox 3.0 includes several new features that allow the developer to provide more functionality with less effort. These are the improvements that have the most practical application to everyday work. They are easy to explain, as good ideas usually are, even though they will have a major impact on the style of Paradox applications.

Paradox now supports multitable forms and multitable reports. This means that you can display or print information contained in tables other than the selected table. A multitable form can include a scrolling region, in which the user can scroll through groups of records. A multitable form can also establish a linkage among the tables, so that information presented in a scrolling region can be selected automatically, based on the specification of the relationship.

Linked forms give Paradox the ability to perform automatic referential integrity, another feature that reduces the developer's work load. If the value in the linking field of a master record is changed, all of the detail records will be changed as well. Further, the master record cannot be deleted until all the detail records have been deleted.

Paradox still lacks one feature that would work nicely with multitable forms: the ability to display calculated fields in a form. The classic example of the benefit of multitable forms is an invoice (which has a single set of customer information, but can have several line items). A linked, multitable form allows the invoice to be displayed; what you cannot see, however, is the amount of tax, the total freight charges, or the grand total for the invoice. This requires the developer to do some extra programming in PAL.

The price for Paradox 3.0 is $725. Version 2.0, which unlike 3.0 can run on a dual-diskette system, is still available for $495. The drop in price for version 2.0 will appeal to price-sensitive buyers, so I suspect its market will remain for some time. Upgrades to 3.0 cost $175 for registered users. A new version of the Paradox LAN Pack supports five users and costs $995.

The emphasis of Paradox's developers has always been to provide a data-management tool that simplifies many of the difficult tasks of building an application. That, in turn, makes the developer's job easier. In this sense, Paradox has much in common with an expert system—the developer specifies goals in a rather abstract form and Paradox figures out how to reach those goals. All of the relational enhancements build upon this philosophy and make Paradox 3.0 an even better, more powerful product than it was before.

WHO OWNS EMERALD BAY?

The many press reports of the dire financial straits in which Migent finds itself may lead some to assume that Emerald Bay, Wayne Ratliff's sequel to dBASE, is near death. (Ratliff, formerly of Ashton-Tate, is the inventor of dBASE.)

Migent arranged for interviews during Fall Comdex to demonstrate the new Emerald Bay server. I took that opportunity to ask Ratliff the rather direct question, "Who owns Emerald Bay?" The answer was equally direct: "Ratliff Software Productions Inc. owns Emerald Bay."

Ratliff's company (RSPI) has an exclusive distribution agreement with Migent. As you might expect, if Migent expires, then so does the agreement. Ratliff assured me that even if Migent does bite the dust, he personally has adequate resources to see Emerald Bay through. The clear message is that Migent is more dependent on RSPI and Emerald Bay than vice versa.

Those PC systems developers currently investing their time and energies building applications using Eagle—the Emerald Bay application language—and the forthcoming server should take heart from this news. Migent is working hard to recover, but the Emerald Bay technology is alive and well, no matter what the outcome.

SMARTBASIC

Microsoft recently began shipping a new version of QuickBASIC (QB), designated 4.5. This edition is worth noting on a number of fronts.

The first point of interest is that QB 4.5 represents *no* performance improvement over QB 4.0. (This may account for the half-increment change in the version number.) Microsoft compares the new version not with 4.0, but with the even older 3.0. In the past, language releases have attracted attention primarily because of better performance, although most releases also incorporated other improvements.

If not performance, then what? Microsoft conducted some market research about QuickBASIC, which led to a number of adjustments to the product. One of the changes is the reassignment of the product out of Microsoft's systems software group and into the applications division. This shift is a recognition that the natural constituency for BASIC is broader than for systems products. It has long been the most likely first language for people who have decided they are going to write a program.

QB 4.5 is designed to capture that new programmer. Whereas QB 4.0 has long, relatively complex menus, 4.5 starts out with much shorter, simpler menus. QB 4.0's file menu, for example, has 12 items; the new one has 5. The more experienced user can still opt for longer menus.

The two most important additions to QuickBASIC are called QB Express and QB Advisor. QB Express is a tutorial for the novice programmer. The more significant improvement, however, is QB Advisor, a hypertext-based, context-sensitive help system. It contains the entire QB manual.

In a typical hypertext environment, certain key words are highlighted. The user can point to these explicit links to move to additional information related to either the current topic or specific areas of the help system—the index, for example. QB Advisor expands on this concept with implicit links, which allow any word in the help text being displayed to be the key word.

This is a powerful concept. The developers at Microsoft may be able to guess which words should be key words or explicit links, but they can hardly anticipate the way a particular developer might think and, as a result, what additional help that developer might actually want after reading a help

screen. With implicit links, the QuickBASIC user can decide how to navigate the help system.

QB Advisor offers general-purpose help. The user can get help for any object tagged by the cursor. If the cursor is in a dialog box, for example, pressing the help key will result in advice about that dialog box. Help is similarly available for all items on QB's menus and for error messages.

Perhaps the most helpful extension is QB Advisor's ability to provide information about user-defined objects, such as variables and subroutine names. QB Advisor displays a lot of information about the item, and, most importantly, where to find the definition.

Although these changes and improvements are aimed at the less experienced user, they in no way reduce QB's value as a programming environment for anyone needing to whip out a quick program. The general availability of BASIC over the years means that most of us know the language well enough to use it quickly and efficiently. Because QB is an incremental compiler, its interactive behavior is just as fast as interpreted BASICA, with the added benefit of the excellent performance of a compiled program.

The price for QB 4.5 remains $99. An upgrade from 4.0 is $25; upgrades from any other version are $50. For those using BASIC on a regular basis, QuickBASIC 4.5 is the version to have.

DESK- OR BUBBLE JET?

Two new printers based on ink-jet technology hit the market last year at approximately the same time: Hewlett-Packard's DeskJet and Canon's BJ-130 Bubble Jet. Due to the DeskJet's popularity, however, the Bubble Jet has quickly faded into near obscurity.

The DeskJet is doing well for many sound business reasons—availability, good marketing, and an advertising blitz—but one reason above all others drags the buyer in: the difference between DeskJet and LaserJet output is barely noticeable.

With the LaserJet, HP showed a keen sense of what the business buyer really wanted. Even while Apple was dazzling us with the PostScript-based LaserWriter, businesses were snapping up the less expensive LaserJet models to replace other forms of letter-quality printing, most notably the daisy-wheel printers. Lasers offered both a consistent output quality and a considerably lower noise level. This success is being repeated with the DeskJet.

Like all HP output devices, the DeskJet is built well and conveys a feeling of quality and reliability. HP paid careful attention to its design, from the front panel controls to the two easily accessible font cartridge slots. A particularly welcome control, similar to one originally found on Texas Instruments' 850 and 855 printers, is the font-select key, which allows users to select fonts manually when their software cannot directly control the printer. The panel also includes LEDs next to a menu of font options so the user can immediately see what the selected font is; this good idea is carried over to the font cartridges as well.

The DeskJet comes with the Courier type face in medium and bold with pitches of 5, 10, 16.67, and 20 and point sizes of 6 and 12. The PC-8 character set is built in and includes the IBM line-drawing characters. HP also introduced 12 external fonts with the DeskJet and obviously put much

thought into their selection. Certain cartridges are a matched set; for example, G provides Helvetica in 4-, 5-, 8-, and 10-point proportional type, while H adds 6- and 12-point. The DeskJet also supports soft fonts, although they cannot be downloaded to the printer without a memory expansion option.

Graphics can be printed on the DeskJet in four resolutions: 75, 100, 150, or 300 dots per inch (dpi).

What makes the DeskJet really stand apart from the Canon Bubble Jet is the blackness of the printing, which, combined with the 300-dpi resolution, makes DeskJet output look very much like LaserJet output. The blackness has one drawback, however. Large black regions, such as might be found on a graphic image, are very wet coming out of the printer, and the paper wrinkles in those areas as the ink dries.

The DeskJet has two other weaknesses. The water-soluble ink smears very easily, sometimes with no more than the normal skin moisture present on fingers. The ink settles in with time and becomes less vulnerable, but it is by no means as permanent as some other printing solutions.

The second weak spot, one that might not be immediately obvious to the buyer, is that text can be printed in portrait mode only. Graphics, however, can be printed in either portrait or landscape, because they are not dependent on the printer's fonts.

The DeskJet is priced at $995, but is heavily discounted; ads in the *New York Times* have shown street prices as low as $575. With pricing like that, the DeskJet is surely taking a large chunk of business away from dot-matrix printers, just as the LaserJet stole the market from the daisy wheel.

Where does that leave the Canon BJ-130 Bubble Jet? Out in the cold, I'm afraid, although it has several redeeming features. Its most important advantage is in paper handling. The BJ-130 is configured like a typical dot-matrix printer with a platen and optional tractor-feed mechanism. Its wide carriage accepts standard 14.875-inch pin-fed paper, regular 8.5-by-11-inch sheet-fed paper sideways, or legal-size paper in landscape mode. The printer has a built-in, cut-sheet feeder that holds 100 sheets. The feeder guides are adjustable for paper widths from 7 inches to just under 15 inches.

The BJ-130 has slightly higher resolution (360 dpi) than the DeskJet (300 dpi), giving both graphics and text a marginally crisper appearance. That advantage is lost, however, because the printing is not as dense as that of the DeskJet; BJ-130 output appears rather grayish by comparison.

The duty cycle of both machines is about the same. HP bases its life cycle of 60,000 pages on average usage (50 pages per day, 12,000 per year). Canon gives the life of the print head as 100 million characters in high-quality mode and 200 million in high-speed mode; this calculates to about the same lifespan as the DeskJet, based on an average of 3,000 characters per page.

Canon is an industry leader when it comes to printing technology. After all, Canon laser engines power the two most popular laser printers in the world (HP LaserJet and Apple LaserWriter). Canon also is developing interesting technology in the color bubble-jet arena. It has a prototype of a 200-dpi color printer that prints at 33 pages per minute once the image has been loaded (using a full-width print head) and has color copi-

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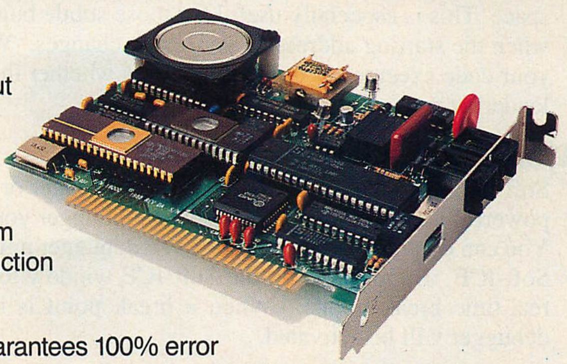

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ers that reproduce using 400-dpi bubble-jet engines. Canon's color technology undoubtedly will drive the price of fast and efficient color printing down to levels close to that of current black-and-white printing in the not-too-distant future.

Unless it is worried about competing with one of its biggest customers, Canon should read from the book of HP if it wants to build printers that the individual buyer finds compelling.

ABOVE BOARDS EVOLVE

Just over a year ago, I wrote about EMS 4.0 ("The EMS Odyssey," New Directions, December 1987, p. 23). I used that opportunity to explain why Intel's Above Board line was probably not the best to buy if you were interested in running either Quarterdeck's DESQview or Microsoft Windows, both of which take advantage of the additional hardware support present on AST's enhanced EMS (EEMS) Rampage and Advantage boards.

This past fall, that situation changed when Intel's Personal Computer Enhancement Operation (PCEO) took steps to improve its memory boards. First, the Above Board Plus (for the PC and AT) now has hardware support, similar to that of the AST EEMS boards, that allows software vendors to exploit EMS 4.0. This means that Intel and AST have reached a technical parity in their products and that the multitasking performance of DESQview and Windows is no longer impaired with Intel products. PCEO offers a $100 upgrade to its Above Board 286 customers; no upgrade is available for models that predate the 286 version.

PCEO also dropped all previous models from its line, leaving three boards: Above Board Plus, Above Board Plus I/O (with serial and parallel ports), and Above Board 2 Plus (for the PS/2), all of which support expanded memory. The situation is more confusing for AST's boards, some of which support expanded memory and some of which do not. Buyers are more likely to opt for Intel's simpler path.

Intel's improvements should allow it to widen its lead in the market. Storeboard Inc., a market research firm in Richardson, Texas, that tracks retail sales through computer stores, says that during the last 12 months, Intel sold about 58,000 boards compared with AST's 41,200; that is three Intel boards for every two AST boards sold in the retail channel.

SCHOOL FOR WINDOWS

Doing software development work under Microsoft Windows is no picnic, as most developers who are just learning the environment will be glad to tell you whenever they are not emitting primal screams. Microsoft, through its Microsoft University, has a Windows Developer course, but training does not come cheap—$1,250 at the university in Redmond, Washington, as well as the associated travel costs.

Windows is finally on the move. Microsoft recently counted 1.5 million users of Windows worldwide, growing at the rate of 70,000 new users per month. The last quarter of 1988 saw the announcements of 44 new Windows applications. That growth has spurred interest in the Windows Software Development Toolkit (SDK), and Microsoft claims that 25,000 SDKs have been shipped to date. More significantly, it is safe to say that nearly 20,000 of those copies have shipped during the past year.

That means there are about 25,000 of us who probably could use a leg up, but not everyone can attend Microsoft University. Fortunately, Microsoft offers an alternative.

The university now provides an extension in the form of a video course. The beautifully packaged course includes five VHS video tapes with between five and six hours of programming, a student workbook, a lab notebook, and four diskettes with lab exercises and support software. To get the most from the course, you need a copy of Windows/286 ($99) or /386 ($195), the SDK ($500), and Microsoft C ($450). The course itself costs $1,960. Additional workbooks are available at $210 per copy or $195 in lots of five or more, so training six developers would end up costing $2,935, or a very reasonable $490 per person.

For the novice to Windows, the biggest problem with the SDK, no matter how experienced otherwise, is getting over the conceptual humps. It is not that the message-passing architecture is hard to understand; what is difficult is wading through the poor, primarily fact-based SDK documentation to figure out how Windows applications should be put together. As I have so often pointed out, the classic, three-line C application, HELLO—the one that displays "Hello world"—mushrooms to three *pages* in Windows and is enough to intimidate the bravest soul at the outset.

The video course provides that missing conceptual help. For example, the lab exercises in the first section instruct the developer on the installation of both Windows and the SDK; two demo programs are compiled, linked, and executed as verification that the installation has gone correctly. That sounds rather simple, but I have personally struggled with the installation of the SDK and the C compiler; the instructions in the lab exercises are clear and easy to follow.

As the course moves on, it takes each important area one step at a time. It explains the resource file (.RC), why the WINDOWS.H header file is so important and what it contains, how the resource editors work, the division of functions between WinMain and WindowProc, and so on. In each case, the subject covered is not so broad as to create confusion, and each topic builds on previous work so that the important concepts begin to sink in. It takes about a dozen labs before the student compiles and runs the first program, which does nothing more than place a window on the screen.

The final exam consists of writing a complete Windows application that, at the very least, includes a set of specified capabilities; successful students will find that the programs they have been writing throughout the course will meet most of those requirements.

The course really should be thought of as an introduction to Windows, rather than a full exposition. The approach and style of the video training are compelling. It can be taken at a pace commensurate with the skill of the student, and material not clearly understood can be reviewed as many times as desired. Most of the tasks the student must do to complete the lab exercises are clearly spelled out. If the course is followed closely, students should understand Windows and the application development process by the time the work is done.

As for the investment of time, Microsoft University says the course can be completed in 8 hours. I suspect that 20 to 40 is more likely.

Having the course in-house makes it an invaluable way to train new members of a development team. I credit Microsoft with a good effort here, the best to date in the important mission of creating capable Windows and Presentation Manager developers.

Will Fastie is the editorial director and founding editor of PC Tech Journal.

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SYSTEMS

A line of 25-MHz 386 microcomputers has been developed by **AST Research**. Incorporating AST's SMARTslot architecture, an advanced arbitrated bus architecture that accommodates multiple intelligent coprocessors, the **Premium 386/25** includes high-speed cache memory architecture based on Intel's 82385 controller and 32KB of cache memory. The 386/25 has a modular design consisting of a system board (which houses the ROM BIOS, diskette drive controller, two asynchronous serial ports, one parallel port, and seven slots) and a separate plug-in CPU card (which contains the 80386 chip, cache controller, memory, and socket for a math coprocessor).

The system comes with 2MB of RAM, expandable to 4MB on the CPU card (with a system maximum of 16MB). The Premium 386/25 features switchless configuration via firmware and software-selectable password security for keyboard, system start-up, and network file-server protection. Four Premium 386/25 models are available. Prices range from $6,595 for the base model to $11,795 for the 320MB hard-disk model.

AST's current Premium/386 line of computers will be replaced with the **Premium 386/C** line featuring an advanced zero-wait-state cache-memory architecture and expanded-memory capacity. The AST Premium 386/C is configured with ASTEMM, an EMS 4.0-compatible expanded memory manager (EMM) utility. 1MB system with no hard-disk drive, $4,395; 2MB system with a 320MB hard-disk drive, $9,795.

AST's microcomputer based on Intel's 16-MHz 80386SX is now available. The **Premium Workstation/386SX** incorporates two 8/16-bit, full-length slots, I/O ports, and video and diskette controller on the system board. Performance and throughput are maximized by 32KB of high-speed cache memory. Standard features include 1MB of RAM, two serial ports, a bidirectional parallel port, integrated diskette and hard-disk controllers, support for an 80387SX, and a system-board connector for the optional no-slot video modules. Available in five configurations, the prices range from $3,195 for the base system (with no hard disk) to $5,195 for a system with a 110MB hard-disk drive.

AST Research Inc., 2121 Alton Avenue, Irvine, CA 92714-4992; 714/863-1333

CIRCLE 303 ON READER SERVICE CARD

A 25-MHz, 80386-based microcomputer has been introduced by **Dell**. The **Dell System 325** comes standard with 1MB or 4MB of RAM (expandable to 16MB using a dedicated high-speed, 32-bit memory slot). It has an Intel 82385 cache-memory controller with 32KB of high-speed static RAM cache; page-mode interleaved memory architecture; a high-performance, 16-bit video adapter for VGA monitors; a socket for the 25-MHz Intel 80387 or 25-MHz Weitek 3167; a 1.2MB 5.25-inch or 1.44MB 3.5-inch diskette drive; one parallel and two serial ports; and eight AT-compatible expansion slots.

The 25-MHz Dell System 325

The System 325 is available with a 150MB or 322MB ESDI hard-disk drive and a VGA monochrome or color monitor. Prices range from $6,999, for a 150MB system with 1MB of RAM and a VGA monochrome monitor, to $11,399, for a 322MB system with 4MB of RAM and a VGA color monitor.

Dell Computer Corporation, 9505 Arboretum Blvd., Austin, TX 78759-7299; 512/338-4400; 800/426-5150

CIRCLE 302 ON READER SERVICE CARD

A Micro Channel-compatible computer, the **MicroFlex 7000**, has been announced by **Advanced Logic Research** (ALR). Designed to compete with IBM's PS/2 Model 70-A21, the MicroFlex 7000 is a 25-MHz 80386-based machine. ALR's MicroFlex 7000 implements a 128-bit bus design and comes standard with 128KB of 25-ns static cache memory. ALR has designed a prefetched proprietary cache to increase memory performance.

Standard features include 2MB of 80-ns, 128-bit, page-mode RAM expandable to 16MB on the system board; a 16-bit VGA integrated on the system board, supporting an 800-by-600-pixel graphics resolution with CGA, EGA, MCGA, and VGA software mode compatibility; five-drive capacity; and a 1.44MB 3.5-inch diskette drive.

Two models are available: MicroFlex 7000-120A21 with a 120MB, 28-ms ESDI hard-disk drive and controller, a 1:1 interleave, and a 16KB look-ahead cache; and MicroFlex 7000-300A31 that incorporates a high-speed 300MB, 15-ms ESDI hard-disk drive and controller, 1:1 interleave, and as much as 32KB of RAM in a look-ahead cache. MicroFlex 7000-120A21, $9,499; MicroFlex 7000-300A31, $12,499.

Also available from ALR is the **FlexCache SX386**, a microcomputer based on Intel's 16-MHz 80386SX. The chip is placed on a CPU card that is set in the six-slot backplane. The Flex-

Microflex 7000 microcomputer from ALR

EarthStation-IIe diskless workstation

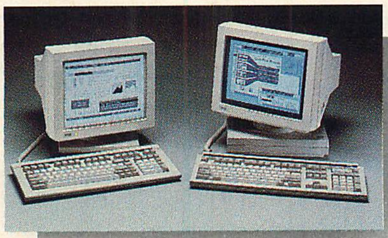
Cache SX386 features an Intel 82385 cache memory controller with 16KB of 35-ns cache memory. It provides two-way set associative caching, transferring twice the amount of data into the cache at one time. The standard memory configuration includes 1MB of RAM expandable to 8MB on the CPU card. Other standard features include a 1.44MB 3.5-inch diskette drive, one serial and one parallel port, and five AT-compatible slots. Base price, $2,595; enhanced version with a 40MB 28-ms hard-disk drive, $3,799.
Advanced Logic Research Inc., 9401 Jeronimo Road, Irvine, CA 92718; 714/581-6770; 800/444-4257
CIRCLE 301 ON READER SERVICE CARD

CONNECTIONS

A software package for Microsoft OS/2 LAN Manager that allows Novell NetWare users transparently to access OS/2 LAN Manager file servers using standard NetWare commands has been unveiled by INTERLAN. The **LMN Server** offers true interoperability between NetWare and OS/2 LAN Manager networks. Designed to operate with all OEM versions of OS/2 LAN Manager including 3Com's 3+ Open, the LMN Server gives NetWare workstation users access to LAN Manager-based servers with no change in software or command interface. LMN Server emulates the services provided by NetWare, including login, directory access rights, active connection information, and print spooling. It supports medium access control (MAC) drivers written to the Microsoft Network Driver Interface Specification, which allows users to implement controllers conforming to the standard. $895.
INTERLAN Inc., 155 Swanson Road, Boxborough, MA 01719; 508/263-9929; 800/526-8255
CIRCLE 310 ON READER SERVICE CARD

A 286 diskless workstation contained in a keyboard has been created by **Earth Computer Technologies.** The **EarthStation-IIe** uses Intel's 12-MHz 80286, is expandable to 4MB of RAM, has an IEEE Ethernet standard interface, and incorporates a video adapter that is compatible with VGA, EGA, CGA, and Hercules standards. A hot-key sequence calls up a menu-driven setup utility, which configures the video mode, the diskless boot type, and the speed mode, with no switches or jumpers to set. Two diagnostic LEDs indicate proper connection. Diskless boot for Novell NetWare 2.0a, 2.1*x*, and ELS, and NETBIOS for all NETBIOS-compatible networks is included. $1,995.
Earth Computer Technologies, 10525 Lawson River Avenue, Fountain Valley, CA 92708; 714/964-5784
CIRCLE 312 ON READER SERVICE CARD

Two computer display terminals have been released by **Wyse Technology**. The **WY-212m Network Terminal** has an Intel 12.5-MHz 80286, but no disk storage, and works over a LAN using servers to store operating systems, programs, and data files. Working in Novell



The WY-150 and WY-212m terminals from Wyse

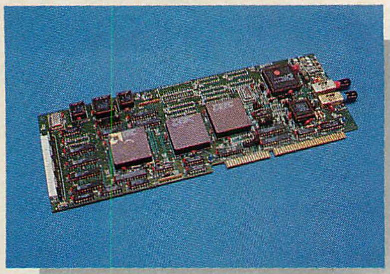
and 3Com networks, this terminal features an IBM VGA-compatible display that is integrated into its compact one-piece design. It has a socket for an optional Intel 80287. The unit incorporates two RS-232 serial ports and a Centronics parallel port. The system board comes with 1MB of RAM.

A general-purpose terminal, the **WY-150**, features a high refresh rate for a screen that is essentially flicker-free and an overscan display eliminates dark borders and provides a less cluttered viewing area. Users have the option of selecting a screen that appears as a paper-white page with ink-black lettering. WY-212m Network Terminal, $1,999; WY-150, $549.
Wyse Technology, 3571 North First Street, San Jose, CA 95134; 408/433-5612; 800/438-9973
CIRCLE 313 ON READER SERVICE CARD

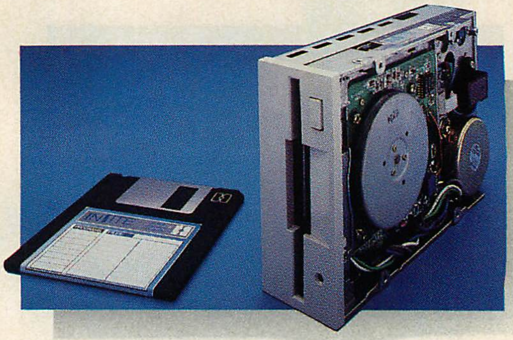
An addition to the 3270/II family of emulation products, the **AST-3270/ SNAGATE II**, has been introduced by **AST Research**. The SNAGATE II is a remote Systems Network Architecture/ synchronous data link control (SNA/ SDLC) 3270 LAN gateway that allows as many as sixteen 3270 display or printer sessions per gateway with multiple gateways per LAN. Each workstation on the LAN may have as many as five display or printer sessions. The AST-3270/ SNAGATE II shares common features of AST's 3270/5250, such as multiple display and printer sessions, automatic sign-on sessions, keyboard macros, configurator and emulator security, and AST Windows Manager.

Gateway master polling support has been added to SNAGATE II and AST 5250 products. Gateway master polling supports multiple gateways per LAN; it has a priority system where a designated LAN workstation can use only a named gateway master while other workstations can use all available gateway masters. $1,295.
AST Research, Inc., 2121 Alton Avenue, Irvine, CA 92714-4992; 714/863-1333
CIRCLE 309 ON READER SERVICE CARD

A set of management utilities for Novell networks from **Cheyenne Software** provides a safer means of storing and retrieving vital network information.



The fiber-optic LaserLAN from Simple NET Systems



The high-capacity Insite Model I325 Floptical Disk Drive from Insite Peripherals

NetBack features a file-management system, a safe storage of bindery and key file-server information, the ability to rebuild a server quickly, automatic backup of directory rights, complete user- and disk-status reports, and other management tools. NetBack can be used with all versions of Advanced NetWare 2.0 and 2.1. VaultFile, a feature built into NetBack, provides safe storage of file-server information on a hard disk or diskettes. VaultFile can create a new file server by duplicating an existing server's information. $245.
Cheyenne Software Inc., 55 Bryant Avenue, Rosyln, NY 11576; 800/243-9462; 516/484-5110
CIRCLE 332 ON READER SERVICE CARD

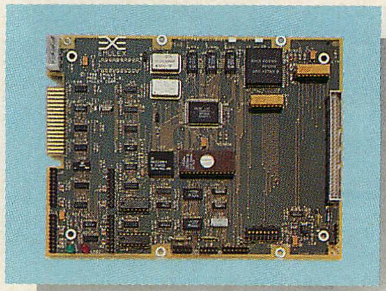
A 100-Mbps, fiber-optic LAN for 286- and 386-based microcomputers is available from **Simple NET Systems**. The high-performance, fiber distributed data interface (FDDI)-compatible networks, called **LaserLAN** and **LaserLAN PLUS**, are based on Advanced Micro Device's SUPERNET chip set and features a full-size, 16-bit adapter with 128KB of on-board packet buffer memory. Neither direct memory access (DMA) channels nor AT-bus memory space is required. Because the adapters are compatible with each other, users can implement both LaserLAN systems on the same fiber-optic ring.

Simple NET Systems offers its proprietary NETBIOS-compatible operating system software, MicroLINK, as an option, with site licenses available on request. The entry-level LaserLAN system can transmit as far as 500 meters per fiber-optic segment. The LaserLAN PLUS transmits as far as 1,500 meters per fiber-optic segment. LaserLAN, $4,095 per node; LaserLAN PLUS, $5,495 per node; MicroLINK, $225 per node.
Simple NET Systems Inc., 545 West Lambert Road, Suite A, Brea, CA 92621; 714/529-8850; 800/262-8010
CIRCLE 311 ON READER SERVICE CARD

PERIPHERALS

A very high-capacity (VHC) flexible-disk drive has been introduced by **Insite Peripherals**. The **Insite Model I325 Floptical Disk Drive** features 25MB of unformatted (20.8MB formatted), removable disk storage in a 3.5-inch form factor. Designed to connect to and operate with existing SCSI host adapters, the I325 Floptical Disk Drive combines optical and magnetic technology using ordinary 1.44MB 3.5-inch diskettes encoded with optical server tracks for higher track density. The I325 drive track density is 1,250 tracks per inch (tpi), with 24,145 bits per inch (bpi). The average seek time is 65 ms. In OEM quantities, $250 each.
Insite Peripherals, 2363 Calle Del Mundo, Santa Clara, CA 95054; 408/727-8484
CIRCLE 304 ON READER SERVICE CARD

Emulex has released a new member of its SCSI disk controller family. Incorporating the Emulex SCSI Processor (ESP) and Merged Architecture Chips, the **MD25** is a single-ended, SCSI-to-



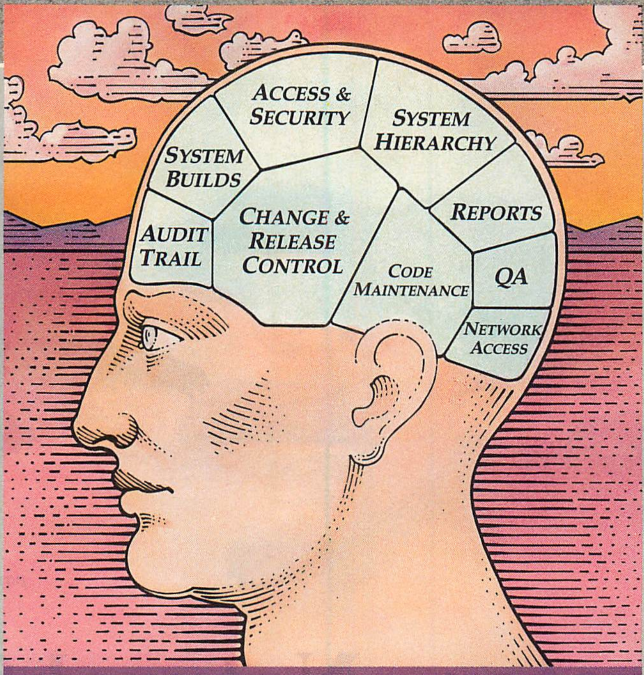
MD25 SCSI disk controller from Emulex

ESDI disk controller that supports as many as four industry-standard, 5.25-inch disk drives and can handle SCSI data-transfer rates up to 4MB per second (MB/s) in asynchronous mode and 4.8 MB/s in synchronous mode.

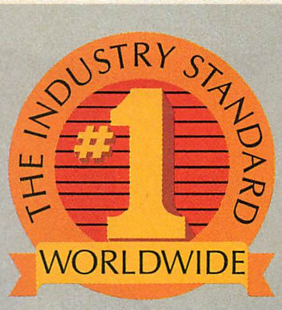
The MD25 is compatible with ANSI X3.131-1986 for SCSI and supports the SCSI Common Command Set, as well as the disconnect and reconnect features essential in multiple-drive specifications. Other SCSI features include support of overlapped seeks and command queuing on a per logical unit number basis. $495.
Emulex Corporation, 3545 Harbor Blvd., Costa Mesa, CA 92626; 800/368-5393; 714/662-5600
CIRCLE 308 ON READER SERVICE CARD

Two members from **Metheus Corporation**'s family of Ultra Graphics Accelerators are designed for PC-based graphics. The **UGA 1124** and **UGA 1128** include improved drawing speed, additional color bit-planes, added display emulation, and 3-D support. Display resolution of the new controllers is 1,024-by-768 pixels. The UGA 1128 is engineered for 3-D with eight bit-planes, permitting 256 colors to be displayed from a standard palette of 16.7 million. The UGA 1124 provides 16 colors from a palette of 4,096. Display emulation includes VGA, EGA, and CGA for applications that do not require high resolution. UGA 1124, $2,195; UGA 1128, $2,595.
Metheus Corporation, OGC Science Park, 1600 N.W. Compton Drive, Beaverton, OR 97006-6905; 800/638-4387; 503/690-1550
CIRCLE 333 ON READER SERVICE CARD

A 16-bit memory board for the IBM PC/AT and compatibles is available from **Tecmar**. The **ClassicRAM** board brings many of the advanced design concepts of Tecmar's existing MicroRAM board for the Micro Channel architecture of the IBM PS/2 to the AT and compatibles. The single-slot board provides as much as 8MB of RAM using 1 megabit single in-line memory modules (SIMMs). Built-in support will accommodate the future generation of



CONFIGURATION MANAGEMENT MADE SIMPLE



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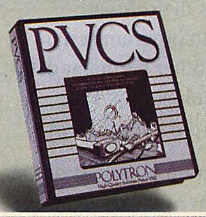

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Jonathan Richey
Director of Product Development
Novell

Adopt PVCS & PolyMake On Existing Projects

You can obtain the benefits of configuration management for your current project without disrupting development, regardless of how long your project has been under way. You can build PVCS archives from revisions stored in your present archives or simply adopt PVCS from the current date.

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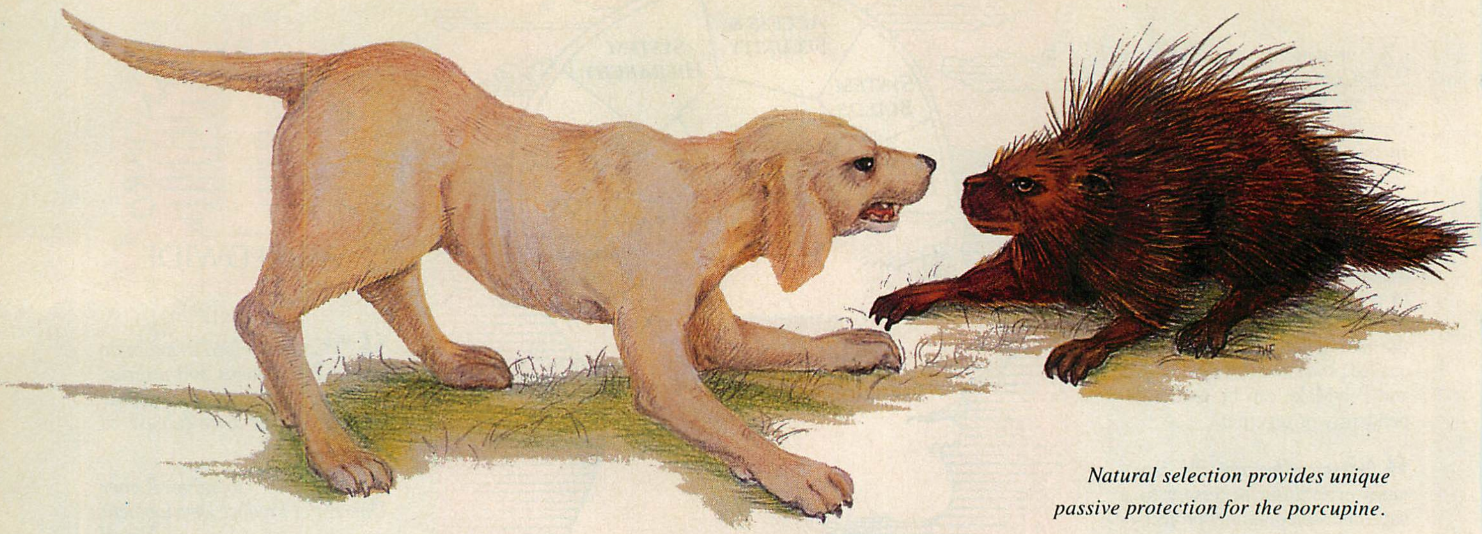

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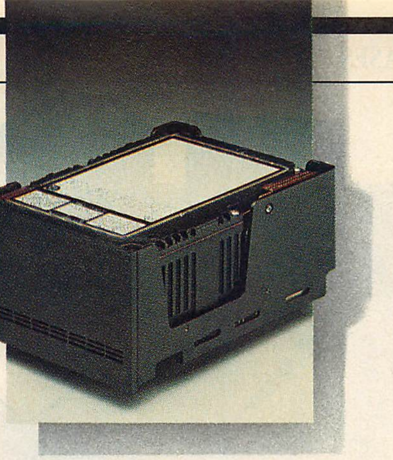
NEC's MultiSync 3D color monitor



1590 Series Model 1598-15 hard disk from Micropolis

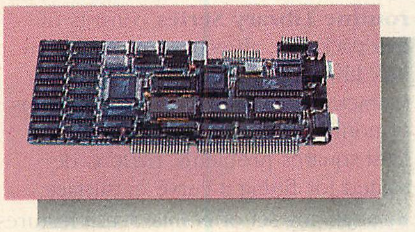
4MB SIMMs. The design simplicity of SIMM technology allows the user to upgrade the memory of ClassicRAM in 512KB or 2MB increments, using 256KB or 1MB SIMMs.

Built-in hardware support for multitasking makes the full 8MB of RAM available under EMS 4.0. ClassicRAM is also compatible with EMS 3.2, Enhanced EMS (EEMS), OS/2, Xenix, and Novell's NetWare. The board can be configured to run at bus speeds as fast as 12.5 MHz with selectable wait-state operation. ClassicRAM features switchless configuration similar to MicroRAM's design. MicroRAM's optional snap-in serial and parallel I/O modules can also be used on ClassicRAM. Price is not yet available.
Tecmar Inc., 6225 Cochran Road, Solon, OH 44139-3377; 800/624-8560; 216/349-0600
CIRCLE 334 ON READER SERVICE CARD

Two hard-disk drives with 1.2GB storage capacities in a 5.25-inch form factor are shipping from **Micropolis**. The drives feature average seek times of 14 ms and data-transfer rates of 20 Mbps. The **1510 Series Model 1518-15** is equipped with ESDI, and the **1590 Series Model 1598-15** has an embedded high-performance SCSI. Prices are not yet available.
Micropolis Corporation, 21211 Nordhoff Street, Chatsworth, CA 91311; 818/718-5117
CIRCLE 306 ON READER SERVICE CARD

The **NEC MultiSync 3D**, a high-resolution color monitor from **NEC Home Electronics (U.S.A.)**, has been announced. This third generation of MultiSync monitors supports IBM's 8514/A, VGA, PGC, EGA, CGA, MDA, Super VGA (800-by-600 pixels), and the Macintosh II video card. Standard features of the MultiSync 3D monitor include 14-inch diagonal screen, 13-inch viewing area, digital controls for 10 preset frequencies (the monitor automatically identifies input signal and finds matching synchronous information among 10 optimized presets), and the ability to program 19 preset locations to support nonstandard frequencies, 1,024-by-768-pixel maximum interlaced resolution (noninterlaced for all other resolutions). The MultiSync 3D monitor also has .28-mm dot pitch with horizontal frequency to 38 KHz and vertical frequency to 90 Hz, transistor-to-transistor logic (TTL), and analog input signal. $1,049.
NEC Home Electronics (U.S.A.) Inc., 1255 Michael Drive, Wood Dale, IL 60191; 312/860-9500
CIRCLE 305 ON READER SERVICE CARD

A 16-bit VGA board, the **SOTA VGA/16**, has been developed by **SOTA Technology**. The VGA/16 is hardware-register compatible with VGA as well as EGA, CGA, MDA, and Hercules standards. Both 9-pin and 15-pin video connectors are standard. The VGA/16 displays graphics in a 1,024-by-768-pixel resolution with 16 colors, 800-by-600 pixels with 256 colors, and 640-by-480 pixels with 256 colors. In all modes, colors are chosen from a palette of 256,000 colors. An enhanced text mode allows the board to display 132 columns of information on the screen with either 25 or 50 rows. By reducing the number of clock cycles and using a 16-bit bus and BIOS interface, the SOTA VGA/16 requires half of the clock cycles necessary for video access on the IBM VGA. A connector for an optional InPort-compatible bus mouse is standard. 256KB, $445; 512KB, $595.
SOTA Technology Inc., 657 North Pastoria Avenue, Sunnyvale, CA 94086; 408/245-3366; 800/237-1713
CIRCLE 307 ON READER SERVICE CARD



The 16-bit Sota VGA/16

SOFTWARE DEVELOPMENT

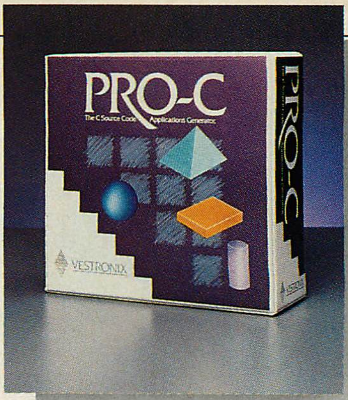
A set of software development tools that eases the task of porting Microsoft Windows applications to OS/2 Presentation Manager has been developed by **Micrografx**. The **Micrografx Windows Emulation Libraries** is a set of OS/2 Presentation Manager dynamic-link libraries that completely duplicates the function calls used by Windows applications to interface with Windows system services.

In many cases, the use of the Windows Emulation Libraries completely eliminates the need to modify any source code. Programs simply need to be relinked, with the Micrografx Windows Emulation Libraries added to their external library list. Most Windows applications will require minor source-code changes to eliminate DOS dependencies.

Windows applications that are ported using the Windows Emulation Libraries automatically take advantage of many advanced features of Presentation Manager, including multitasking, memory access of as much as 16MB, and protected-mode support. Micrografx will license the Libraries to other developers on a case-by-case basis. Prices vary depending on installation.
Micrografx Inc, 1303 Arapaho, Richardson, TX 75081; 214/234-1769; 800/272-3729
CIRCLE 314 ON READER SERVICE CARD

Two software development packages, **Business C Development Tools** for DOS machines and **Commercial C**

MINPACK1-LIB and FITPACK software from McGraw-Hill



PRO-C 1.3 from Vestronix features moving windows

Development Tools for Unix machines, are shipping from **UserSoft Systems**. Both tools work with all popular compilers, including Microsoft C, Turbo C, Lattice C, and Advantage C++. Business C Development Tools consists of three products: SUPERIOR, Structured/Access Method (S/AM), and SCREEN (for DOS machines only).

SUPERIOR is designed to increase a C programmer's I/O productivity and includes features such as ready-made, advanced matrix functions, implementation and simplification of subroutines, and numerous conventions for data and image conversion and string manipulation. S/AM provides unlimited growth for the programmer's relational database system. Some features of S/AM include the ability to create a relational database or indexed file, the ability to create unlimited numbers of alternate or secondary keys with automatic management of alternate key files (virtual tables), mainframe-type database security, high-language access for nonimage data, mixed data field and key length for storage compression, and piracy control to prevent illegal access to S/AM files.

SCREEN, a superset of and functionally compatible with Unix's **curses**, solves the incompatibility problem between PC screen mapping and the Unix representation of a terminal screen. The product has more than 250 screen- and window-manipulation functions. Business C Development Tools (including SUPERIOR, S/AM, and SCREEN), $399. Commercial C Development Tools (including SUPERIOR and S/AM), $499 to $1,999, depending on the computer.
UserSoft Systems Ltd., 1512-409 Granville Street, Vancouver, BC, Canada V6C 1T2 604/681-8872; 800/663-0322
CIRCLE 320 ON READER SERVICE CARD

Vestronix has released an enhanced version of **PRO-C**, the C source code applications generator for DOS, QNX, Unix, and Xenix. **Version 1.3** gives developers the ability to create applications with moving windows, multiple windows, dynamically sized windows, scrolling regions, and subscreens.

A dBASE III interface enables PRO-C applications to access files created using dBASE III. PRO-C 1.3 allows users to view multiple records from one or more data files concurrently. It has full-color support and a redesigned front end. Pro-C's context-sensitive help has been enhanced to include dynamically resizable help windows and the ability to edit the help text supplied. Pro-C does not require a runtime environment. $495.
Vestronix Inc., Allen Square, 180 King Street South, Suite 230, Waterloo, Ontario, Canada, N2J 1P8; 519/745-2700; 800/265-2682
CIRCLE 316 ON READER SERVICE CARD

A series of software packages designed for engineers and scientists who use FORTRAN for problem solving is available from **McGraw-Hill**. The **PC Scientific FORTRAN Mathematical Subroutine Library Series** consists of five packages, all containing ready-to-link libraries and interactive tutorials. MINPACK1-LIB focuses on solving systems of nonlinear equations and nonlinear least-squares problems. FITLIB is designed for fitting a curve or surface through any set of points. FFTLIB features calculations of Fast Fourier Transforms (FFTs), single and multidimensional. SPARGEM is devoted to solving sparse systems of linear equations. QUADLIB deals with solving numerical integration problems. MINPACK1-LIB, FFTLIB, SPARGEM, and QUADLIB, $495 each; FITLIB, $695.
McGraw-Hill Book Company, Professional and Reference Division, Engineering and Science Group, 11 W. 19th Street, New York, NY 10011; 212/337-5945
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A tool to help develop applications in the Microsoft Windows environment has been announced by **SofTools**. **CASE:W** is an expert system created from SofTool's specialized knowledge base of Windows code sets and production rules. It includes a complete programming environment to generate concise, well-structured, pretested Windows code. The package features a special front-end prototyping tool that provides a high-level way to describe the application's windows and controls. Using an inference engine, CASE:W evaluates the prototype specification, applies the stored programming knowledge, and generates the Windows-based application. It automatically produces fully commented code and the necessary operating controls for any Windows applications. CASE:W supports menu bases, pop-up menus, and dialog boxes. $1,495.
SofTools Inc., One Dunwoody Park, Suite 130, Atlanta, GA 30338 404/399-6236
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Several software development products are available from **SLR Systems**. A linker and debugger have been added to the OPT family of development tools. **OPTLINK** is a quick program linker that works with modules in Intel Object Module Format (OMF), including those generated by the standard SLR, IBM, and Microsoft assemblers and compilers. **OPTDEBUG** is a full-featured, compact, source-level debugger that provides the programmer with eight display types. **OPTLIB/2** is an object module librarian that can create and maintain master indexed files or libraries in the OS/2 environment. **OPTLINK/R** is a fast program linker that works in the protected mode of OS/2 and generates real-mode .EXE files. **OPTASM**, SLR's macro assembler, has been updated to **version 1.6** and introduces two new utilities to the package: OLINK, a pro-

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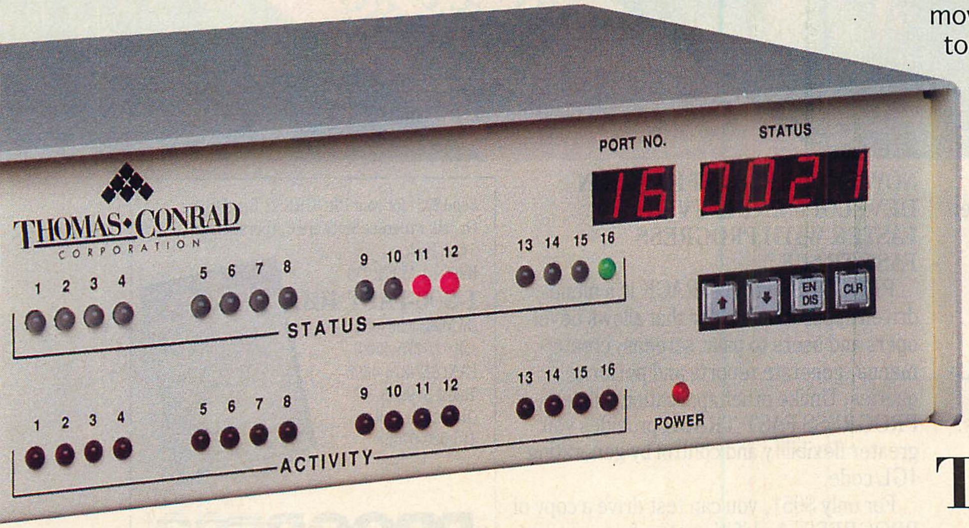

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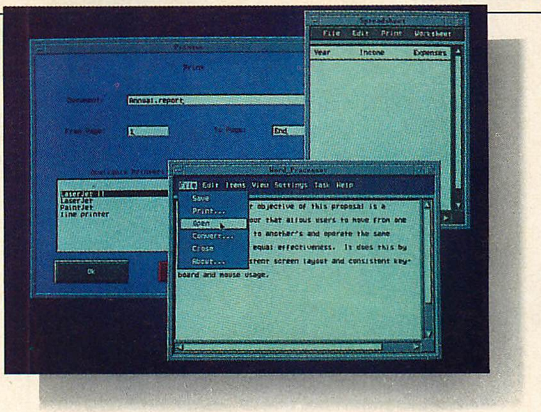
Development Associates' REM86 debugger



Presentation Manager/X from HP and Microsoft

gram linker, and ODEBUG, a debugger. OPTLINK, OPTLINK/R, and OPTDEBUG, $125 each; OPTLIB/2, $49; OPTASM 1.6, $125.
SLR Systems, 1622 N. Main Street, Butler, PA 16001; 412/282-0864; 800/833-3061
CIRCLE 315 ON READER SERVICE CARD

A version of Microsoft OS/2 Presentation Manager for Unix, **Presentation Manager/X**, is being developed jointly by **Hewlett-Packard** and **Microsoft**. The product is an extension of the Common X Interface (CXI), designed for applications portability across multiple operating systems. The CXI gives Unix systems running the X Window System the same appearance and behavior as PCs running DOS with Microsoft Windows and OS/2 with Presentation Manager. Presentation Manager/X has application program interfaces (APIs) that are consistent with Presentation Manager. Presentation Manager/X is built to coexist with X Window; because X Window is the base for CXI, both CXI and Presentation Manager/X will run concurrently on the screen. Price is not vet available.
Hewlett-Packard Company, Customer Information Center, 19310 Pruneridge Avenue, Cupertino, CA 95014; 800/752-0900
CIRCLE 317 ON READER SERVICE CARD
Microsoft Corporation, 16011 N.E. 36th Way, Redmond, WA 98073-9717; 206/882-8080
CIRCLE 318 ON READER SERVICE CARD

A remote debugger from **Development Associates** is available for the FUTURE86 high-level language. The **REM86** debugger consists of a target monitor (written in FUTURE86) that is less than 2KB in size. The remaining part of REM86 is the host-control program, which is functionally similar (but extended) to FDT86, the FUTURE86 host debugger. REM86 supports a patching assembler, file loading, disassembler, immediate execution assembler, high-level definition creation and execution, single stepping, high- and low-level breakpoints, symbolic debugging, and control.

FUTURE86, a prerequisite for REM86, is an open language that allows the generation of free-form, compact programs that can be placed in ROM. FUTURE86 is a two-pass compiler that encourages structured programs and allows forward referencing, conditional compilation, module linkage, and file include directives. The built-in macro assembler supports 8086/88 and 80186/88 instructions. REM86, $479; FUTURE86, $375.
Development Associates, 1520 S. Lyon, Santa Ana, CA 92705; 714/835-9512
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An enhanced version of **Gold Hill Computers**' Common LISP for the PC has been released. **Golden Common LISP** (GCLISP) **Developer 3.1** is faster and smaller than previous releases and offers an improved graphics environment. Gold Hill has improved the following features: function swappping, to reduce memory requirements; input editing, for editing LISP expressions; External Program Interface (EPI), for interfacing to programs written in C under DOS; interactive debugging with compiled or interpreted code; and support for Portable Common LOOPS. GCLISP Developer 3.1 requires an IBM-compatible, 386-based computer with 640KB of base memory and a minimum of 3MB of extended memory (5MB is recommended). $1,995.

Available as an add-on product, the **Gold Hill Windows** graphics package is used to develop windows applications under GCLISP Developer 3.1. Gold Hill Windows uses EPI to interface to Microsoft Windows; it supports bit-mapped graphics, mouse, multiple windows, fonts, color, scrolling, pop-up menus, and command menus. In addition to the GCLISP Developer requirements, Gold Hill Windows requires a color display adapter and monitor, Microsoft Windows/386 2.1 (or later), and 4MB of extended memory. $495.
Gold Hill Computers Inc., 26 Landsdowne Street, Cambridge, MA 02139; 800/242-5477; 617/621-3300
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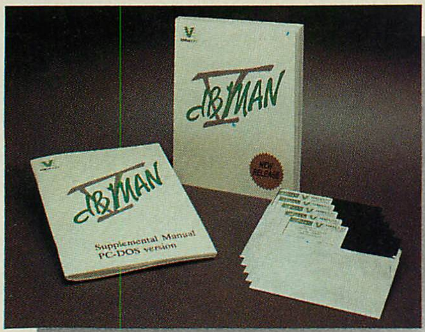
DATABASE MANAGEMENT

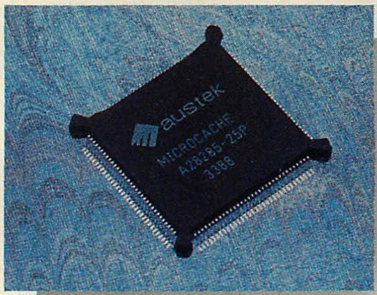
WallSoft has shipped two versions of its applications generator and interface design tool, the **UI Programmer 2** (UI2)—one for professional developers and one for end users. The UI2 for developers includes a set of ready-to-run application templates for Ashton-Tate's DBASE III PLUS and DBASE IV, Nantucket's Clipper, Fox Software's FOXBASE, WordTech Systems' dBXL, and Microsoft C, as well as a power template development environment. The UI2 for end users is a subset of the developer's release and includes a complete set of precompiled application templates for all compatible DBASE applications, so users can generate complete systems without programming.

Both versions contain an editor that allows users to paint screens, menus, and reports quickly and easily. The editor is three-dimensional, for designing pop-up boxes, scrolling look-up windows, and multipage screens. UI2 for professional developers, $595; UI2 for end users, $295.
WallSoft, 233 Broadway, New York, NY 10279; 800/233-3569 212/406-7026;
CIRCLE 323 ON READER SERVICE CARD

A multiuser version of DQUERY, an interactive query management system using IBM DB2-compatible Structured Query Language (SQL) and query-by-example (QBE) for canned and ad hoc queries and report writing, is available from **Quadbase Systems**. Consisting of a



dbMAN V 5.0 from Versasoft



Austek's A28285 cache controller

multiuser relational database engine, an SQL interface, a QBE interface, and a report writer, **dQUERY/Net 2.1** allows users to query dBASE and Lotus 1-2-3 files and to generate reports. It can join Lotus 1-2-3 and dBASE III files transparently, and it can save query results in dBASE III, Lotus 1-2-3, or text file formats. dQUERY/Net 2.1 supports full file locking and sharing, and locking protocol is handled internally.

Quadbase Systems has also announced **dQUERY/Lib/Net 2.1**, a set of routines that can be called by Microsoft C 5.1 and Nantucket's Clipper (summer '87 version). dQUERY/Lib/Net 2.1 gives developers access to dQUERY's mulituser relational database engine. It supports the record-at-a-time and host-variable concepts in IBM's embedded SQL. dQUERY/Net 2.1, $495 for one to five users (a royalty-free runtime version is included); single-user version, $150; dQUERY/Lib/Net 2.1, which includes dQUERY/Net 2.1, $695 for one to five users; single-user version, $295. *Quadbase Systems Inc., 790 Lucerne Drive, Suite 51, Sunnyvale, CA 94086; 408/738-6989*

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A dBASE III PLUS work-alike has been released by **Versasoft**. Compatible with dBASE III PLUS, **dBMAN V** includes more than 320 extended commands and functions of the dBASE III PLUS language. All database-related commands and functions can include an alias name that directs the command or function to the specified database. dBMAN V supports password protection, data encryption, and data security at field level. Vertical, horizontal, and pull-down menus can be created with a single command. Scrollable windows can be created and as many as 20 windows, including screen images, colors, and coordinates, can be pushed and popped. Database files in dBMAN V can be related to many child databases.

dBMAN V includes a Report Writer feature and the Greased Lightning compiler that can compile and run dBASE II PLUS programs at increased speed. It comes with an unlimited license runtime distribution. Single-user version, $189.00; multiuser version for Novell NetWare and PC Network, $499.95. *Versasoft Corporation, 4340 Almaden Expressway, Suite 250, San Jose, CA 95118; 408/723-9044*

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TECHNOLOGY

The **A28285**, an integrated cache controller for 20-MHz and 25-MHz 80286 and 80386SX-based systems, has been introduced by **Austek Microsystems**. The A28285 maximizes the throughput of these microprocessors. Key features are a 32KB or 64KB cache size, 20- or 25-MHz speeds, four-way set associative caching, zero-wait-state reads and writes, a standard 286 interface, separate snoop bus for efficiently maintaining cache coherency, high on-chip integration, least recently used (LRU) replacement algorithm, cache clear control, noncached regions defined by simple external hardware, and a 132-pin JEDEC-standard, plastic, quad flat pack. Price for a minimum purchase of 10,000 units, $35 to $45 each. *Austek Microsystems Proprietary Inc., 22903 Bunker Hill Lane, Suite 201, Santa Clara, CA 95054; 415/960-1313*

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A single-chip, 16-Mbps token-ring communications network processor called the **COMMprocessor** is shipping from **Texas Instruments** (TI). Like its predecessor, the TI TMS380 Token-Ring chip set, the TMS380C16 COMMprocessor maintains compatibility with the IBM Token-Ring Network, IEEE standard 802.5, and IEEE standard 802.2. The COMMprocessor integrates the TMS38030 Communications Processor, the TMS38020/21 Protocol Handler, and the TMS38030 System Interface chips from the original TMS 380 Token-Ring chip set with two very large scale integration (VLSI), standard-cell application-specific integrated circuit (ASIC) functions, the bus-interface unit (BIU), and memory-expansion unit (MEU) available in TI's ASIC LAN Toolkit.

Two other members of the first-generation TMS380 chip set, the TI TMS38051 and TMS38052 ring interfaces, are integrated on a single chip, the TMS38053, an IEEE 802.5-compatible ring interface. The COMMprocessor includes the following features: frame sizes as large as 18,000 bytes; full 32-bit address; as much as 2MB of buffer memory; reduction of less than 10 square inches (the space required to implement a full function); IBM-compatible token-ring adapter; and dissipation of less than one-fourth the power of three N-channel metal oxide semiconductor (NMOS) and two complimentary metal-oxide semiconductor (CMOS) devices that it integrates.

TI will continue supporting the first-generation chip set for cost-effective, 4-Mbps token-ring designs. Texas Instruments is providing complete development support for the COMMprocessor, including a 16-Mbps token-ring design kit, evaluation adapters, and a technical workshop at TI's Regional Technology Centers. In quantities of 1,000: for the TMS380C16 COMMprocessor, $96 each; the TMS38053 ring interface, $24 each. *Texas Instruments Inc., Semiconductor Group SC-876, P.O. Box 809066, Dallas, TX 75380-9066; 800/232-3200 ext. 700*

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The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

Multitasking Software Surprises Experts

"I went through every multitasker that was made for 386 computers, and none of them worked," one user told us. That same person, interviewed in a recent customer survey, said "VM/386™ is one of the finest pieces of software I've ever used...it actually does what it's supposed to do."

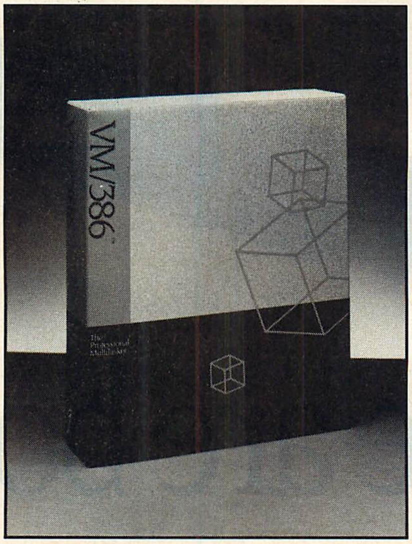
Apparently it isn't easy to find a true multitasking product. Those who have been looking for some time have even rejected other packages.

"We had pretty much given up on a multitasker," another user told us. "We got VM/386, and have subjected it to every piece of nasty code we're capable of writing. We have not even been able to get it to burp...I am impressed."

VM/386 Breaks 640K Barrier

VM/386 makes your computer think that it has more than 640K of memory. In fact, it makes each application think it has its own 640K of RAM—which is especially useful for network drivers.

That's why one user told us to "Forget multitasking! It's kind of handy, I admit, but our people don't do big sorts that often. They *do* load up RAM-resident programs, until they run out of room. VM/386 gets around this problem. I fell in love with it as soon as I found out it really worked."



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Turn *your* 386 into multiple virtual machines, with VM/386. Contact IGC at 4800 Great America Pky., Santa Clara, CA 95054 Tel: 408-986-8373 Toll Free: 800-458-9108

VM/386 Shines in Control Applications

"386 machines are just blasting into the industrial control market," one of our process control experts told us. He had considered OS/2, and had tried other multitasking products. "They crashed on us," he says. Then he tried VM/386. "The overhead was less than 3%, just like they advertised," he says.

He has told other companies about VM/386. "They're as pleased as I am that there's one that works. It's a phenomenal piece of software. (And) the support is excellent."

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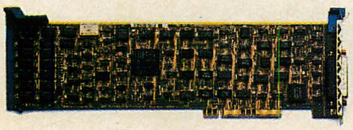

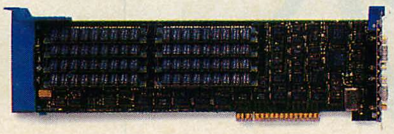

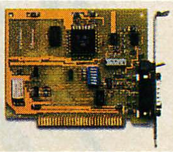

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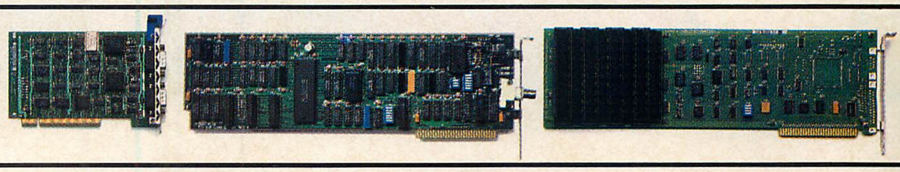

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The OS/2 Puzzle Takes Shape

With the release of OS/2 Extended Edition, IBM provides the tools to develop major corporate applications. The two newest parts of the puzzle, the Communications and Database Managers, unite mainframe concepts with PC functionality.

DENNIS LINNELL

OS/2 Extended Edition is IBM's first attempt to make good on its promise to provide a standardized computing environment for its entire product line—from micros to mainframes. That promise came two years ago in the form of Systems Application Architecture (SAA), the company's strategic plan that defines consistent user interfaces, programming languages, communications, and database management.

OS/2 Standard Edition, the much-debated operating system IBM and Microsoft unveiled in December 1987, provides the user interface and programming-language support. OS/2 Extended Edition supplies the remaining two ingredients: Communications Manager and Database Manager. IBM released Extended Edition 1.0 in July 1988 and 1.1 in November 1988.

Communications Manager, which provides file-transfer services and 3270, asynchronous, and LAN communications, is described in detail in the second article of this month's cover suite ("Cooperative Communications," Dennis Linnell, p. 52). The third article, "OS/2 Meets SQL" (Herbert A. Edelstein, p. 62), describes Database Manager, which supports data definition and manipulation using a Structured Query Language (SQL) compatible with IBM's Database 2 (DB2) mainframe relational database manager.

Although Extended Edition has communications and database facilities, it is not an end-user environment. Rather, it is a base from which to develop applications. It is an operating system like DOS—albeit, more sophisticated. Without applications, DOS is not useful to the typical end user. Extended Edition is no different. Only a professional developer who can program in languages such as C or COBOL can take full advantage of its communications and data-management features.

Moreover, those accustomed to PC communications and database products will find that Extended Edition is in a completely different league because of its mainframe-style facilities. Indeed, developers are likely to find the environment—both its interface and functions—more akin to mainframe than to PC programming.

Extended Edition is not for everyone. It is a tool for developing and running complex applications on the PC. It demands sophisticated hardware; and its many communications and database services require a lot of memory.

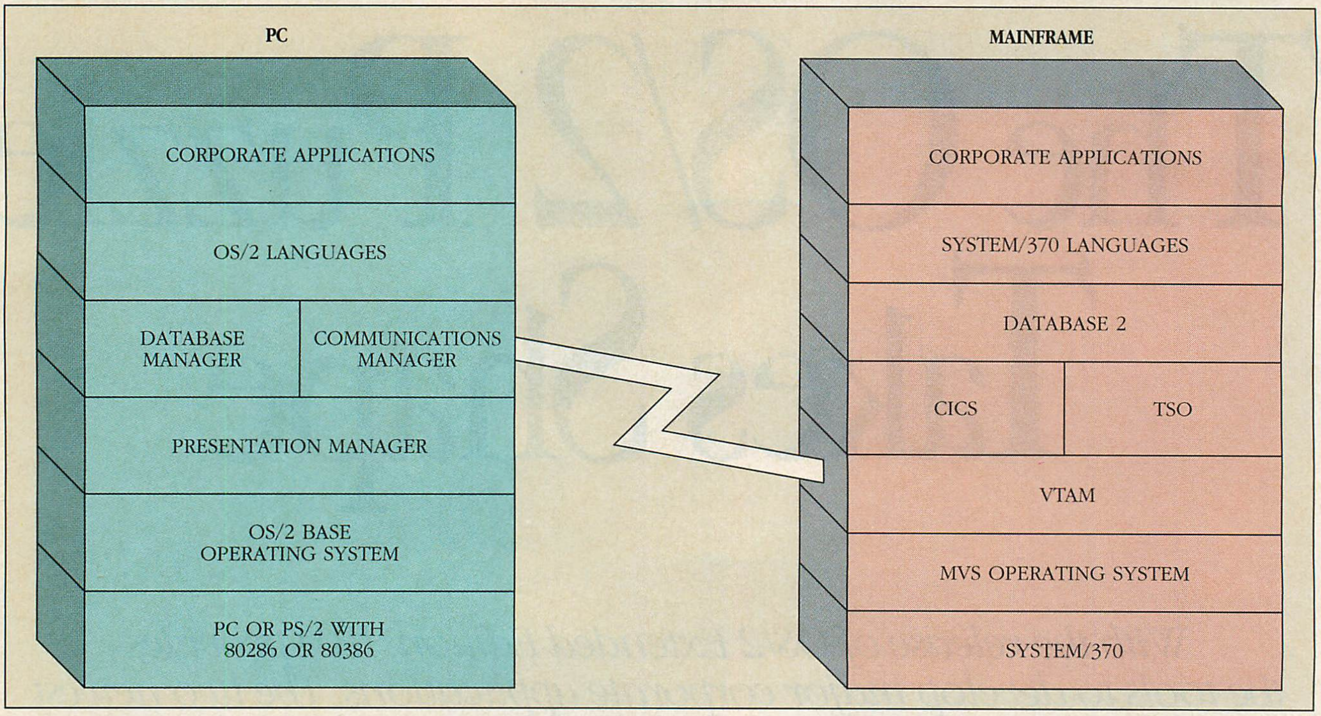
Who, then, will be interested in Extended Edition? Because it is designed to permit PC applications to access IBM mainframes, its primary target group is IBM mainframe customers. Extended Edition operates on only 80286- or 386-based IBM PCs (or close compatibles) and supports only IBM communications boards. Extended Edition is designed in the long run to interact with DB2 running on the mainframe, which already supports many corporate applications.

CORPORATE APPEAL

Most corporate applications are developed for the mainframe because the necessary resources have not been available on the PC. Extended Edition's mandate is to change this scenario. As

ILLUSTRATION • CARY HENRIE

FIGURE 1: ***Cooperative Processing with Extended Edition***



Extended Edition provides a platform for the development and execution of applications that share the data and processing resources of PCs and mainframe computers. Like the System/370 environment, OS/2 Extended Edition provides languages and software services that allow the development of applications with minimal access to base operating-system services.

a high-end PC platform, it provides developers with the memory, multitasking, communications, and data-management services needed to support complex corporate applications.

Development of most corporate applications for the PC has never been practical under DOS. Because of their complexities, such applications are constrained by the DOS 640KB memory limit. Communications functions for mainframe connectivity also gobble up storage, often leaving less than 200KB for applications.

Multitasking, another key requirement for corporate applications, has never been successfully implemented under DOS. IBM's own DOS-based multitasking products, TopView and the 3270-PC, were ill-conceived from an engineering standpoint and failed in the marketplace.

Perhaps a more important drawback than limited memory and lack of multitasking is that DOS does not have the functionality of mainframe application-enabling subsystems. These IBM mainframe packages, such as the Customer Information Control System (CICS), Information Management System (IMS), or Interactive System Productivity Facility (ISPF), facilitate access to data and communications with terminal screens and keyboards.

Despite DOS's limitations, many developers, under pressure to reduce costs, are exploring ways to use the PC as an alternative to traditional mainframe computing. Some of these developers have tried other operating systems, but with limited success. Unix, for example, has the required memory and multitasking features, but has only limited facilities for communicating with corporate mainframes.

OS/2, on the other hand, meets many of the criteria for developing high-end applications. It has sufficient addressing capacity to support complex systems software, as well as a large set of applications. Its 16MB address space and multitasking features accommodate large applications without forcing programmers to use overlays or expanded-memory schemes. Presentation Manager, available now, and the forthcoming OS/2 Dialog Manager provide many important features of the mainframe application-enabling subsystems, such as user-interface and resource-management functions. Equally important, the multitasking features of OS/2 promote efficient client-server relationships, the foundation of many distributed computer systems.

Extended Edition is designed to provide a stable, functional platform for corporate application development—first, because it conforms to SAA and, second, because it provides the required tools and facilities. With Extended Edition, IBM is promoting cooperative processing, which in this case consists of a two-tiered approach with data and processing resources shared by mainframes and PCs running OS/2 (see figure 1).

The technology of Extended Edition will be immediately familiar to those who have worked in the IBM Multiple Virtual Storage (MVS) mainframe environment. Database Manager uses the same SQL interface as IBM's mainframe DB2 or SQL/Data System (SQL/DS) software. The OS/2 Query Manager is strikingly similar to the latest version of IBM's mainframe Query Management Facility (QMF). Applications written in C, COBOL, or Pascal can use the services of the Database and Query Managers directly, through the use of application program interfaces (APIs). Remote Data Services, a planned enhancement to Database Manager, will allow access to data residing on a LAN workstation by using Communications Manager's services.

Communications Manager contains many important features of IBM's Systems Network Architecture (SNA), including 3270 terminal emulation, file transfer, server-requester programming

TABLE 1: *Planned Upgrades for OS/2 Extended Edition*

	VERSION 1.0	VERSION 1.1	FUTURE VERSIONS
BASE OPERATING SYSTEM			
Multitasking	●	●	●
Large memory	●	●	●
Presentation Manager	○	●	●
Files larger than 32MB	○	●	●
Dialog Manager	○	○	●
COMMUNICATIONS MANAGER			
Asynchronous	●	●	●
3270 terminal emulation	●	●	●
File transfer	●	●	●
SRPI	●	●	●
APPC	●	●	●
Token-Ring LAN	○	●	●
PC Network	○	●	●
SNA LAN gateway	○	○	●
X.25 network	○	○	●
5250 terminal emulation	○	○	●
3270 HLLAPI	○	●	●
DATABASE MANAGER			
Relational data manager	●	●	●
Query Manager	●	●	●
SQL support for C	●	●	●
SQL support for COBOL and Pascal	○	●	●
SQL query import/export	○	○	●
Remote access services	○	○	●

● = *Yes* ○ = *No*

Extended Edition 1.1 offers LAN connection as well as basic communications and data-management services; however, users will have to wait for unspecified future versions to provide remote database access and gateway services.

interface (SRPI), and advanced program-to-program communications (APPC). IBM 5250 terminal emulation, used with midrange IBM computers, is planned for the future. Communications Manager also supports non-SNA protocols, including NETBIOS and IEEE 802.2. Asynchronous terminal emulation for the DEC VT-100 and IBM 3101 is included. IBM supplies APIs for all of these communications protocols.

Aside from database query, terminal emulation, file transfer, and system administration, most Extended Edition functions are not available to the end user but are accessible only through APIs. These APIs are crucial because they provide the programming environment for developing applications. This underscores the point that Extended Edition is primarily an environment for sophisticated programs to be used by large corporations.

THE SAA CONNECTION

Extended Edition is the first substantial component of SAA, which represents IBM's primary strategy for cooperative processing (see "SAA: IBM's Road Map to the Future," Dennis Linnell, April 1988, p. 86). The architecture covers three IBM computer families—the System/370 (including 3090, 4381, and 9370), AS/400 (successor to System/36 and /38), and PC and PS/2 models with 80286s or 80386s. SAA also addresses three major issues in designing cooperative-processing applications: Common User Access (CUA), Common Programming Interface (CPI), and Common Communications Support (CCS).

SAA's CUA component defines a consistent user interface (such as OS/2's Presentation Manager) that will be implemented in IBM software as well as a wide range of third-party products. CPI conforms to recognized industry standards in programming, such as C, COBOL, and SQL, allowing applications to be ported across three major IBM computer families and four operating systems—OS/2, OS/400, MVS, and VM. CCS standardizes communications among nearly all IBM products that use popular SNA protocols. CCS also supports non-IBM products using industry standards such as IEEE 802.5 LANs, CCITT X.25 packet switching, and the Open Systems Interconnection (OSI) reference model.

SAA offers real benefits for both IBM customers and third-party applications developers. The consistent user interface defined by CUA makes it easier to learn new applications, thereby reducing training costs. The standardized programming interface facilitates portable applications, allowing a vendor to develop one software product and market it for several IBM computer environments including PCs, midrange computers, and mainframes.

The combination of the programming interface and the common communications support creates the foundation for cooperative-processing applications. SAA protects a customer's investment in software by maintaining an open architecture and by standardizing interfaces and ergonomics.

EASY ON THE INSTALLATION

Although Extended Edition is a complex system, installing it is relatively straightforward. Installation of the base operating system consists of answering a few questions and inserting diskettes as required.

After the base operating system is in place, the user can install the Communications Manager and Database Manager using a single command for each. Both products can be installed at the same time as the base operating system or at a later date. Users are not likely to keep both software packages in their machines unless they really need them, because each consumes 5MB of disk space.

Getting Extended Edition installed and deriving benefit from it are two entirely different goals. The communications sections of the Extended Edition reference manuals frequently mention a systems administrator, and for good reason. Running Extended Edition requires a profile to define the operational characteristics of most functions (workstation, terminal emulation, asynchronous, 3270, SDLC, LAN communications, and file-transfer protocols). IBM provides some sample profiles, but their interpretation and use requires a working knowledge of the mainframe communications network.

Database Manager comes with a useful set of default of values and a sample database, which allows the user to begin getting familiar with the system almost immediately. Users who know IBM's mainframe SQL products will have no trouble using the package;

but, as on the mainframe, primary SQL users are programs, not users. The real test of Database Manager will be the applications developed to employ it.

LOOKING FORWARD

Although it is an IBM product, and IBM generally follows its own lead, Extended Edition has some features that follow established computer-industry directions. For example, the system facilitates the design of applications that use a client-server architecture. Extended Edition's *named pipes,* a Unix-like interprocess communications function, simplifies the programming of distributed applications.

The client-server model and named pipes differ somewhat from IBM's traditional communications philosophy. While not abandoning its cherished proprietary architectures, the company is positioned to be responsive to official standards, such as OSI, X.25, and integrated services digital network (ISDN), as well as unofficial directions such as named pipes.

Extended Edition expands the PC's usefulness by allowing it to work effectively as a communications, database, and applications server. Extended Edition also lays the foundation for multitasking hosts, internetwork bridges, and gateways. Although these functions have been performed under DOS, many implementations are awkward and perform poorly.

Even more important, Extended Edition provides the infrastructure for future use of intelligent communications subsystems, in which networking protocols are handled by a separate, dedicated processor. The system eventually could support a true multiprocessor configuration, allowing multiple CPUs, each available to execute any task in the system.

IBM has big plans for Extended Edition. As originally released, version 1.0 has rather limited capabilities (see table 1). Version 1.1 adds LAN support to Communications Manager, plus Presentation Manager (first released in Standard Edition 1.1) and large file (greater than 32MB) support. IBM has announced many enhancements, but has not specified delivery dates.

In addition to the asynchronous and 3270 communications supported in version 1.0, Communications Manager 1.1 supports IBM Token-Ring and PC Network LAN operations and a 3270 terminal emulation API consistent with IBM's Entry Emulator High-level Language Application Program Interface (EEHLLAPI). (See "The High Road To Host Connectivity," Michael Triner, January 1989, p. 84.) Planned enhancements to Communications Manager include 3270 and APPC SNA communications via LAN gateways, IBM 5250 terminal emulation, X.25 communications and 3270 data stream translation.

Planned enhancements for Database Manager include remote data access services, SQL precompiler support for COBOL and Pascal, the import and export of SQL queries, a common programming interface for the query facility, and the ability to import nondelimited ASCII files. Together, these features allow multiple network workstations to access a common database with data from non-IBM data managers.

With its array of current and planned features, it comes as no surprise that Extended Edition is fond of high-powered hardware.

MORE THAN THE SUM

Extended Edition follows IBM's three-part formula for product synergy. First, provide an integrated product. IBM accomplishes this by bundling mainframe communications features, a relational database, and a query facility with OS/2. Second, promote the product as an essential part of IBM architecture. In this case, Extended Edition is the first piece to adhere to the SAA master plan.

The third ingredient of IBM's strategy concerns pricing: always price the product below the cost of the sum of its parts. For customers who actually use all of its many functions, Extended Edition is a bargain. For $795, you get an operating system, a full-function relational database, and a kaleidoscope of communications functions. IBM offers aggressive discounts for customers who buy hundreds of copies.

Although the software may be a bargain, hardware requirements are a completely different story. Many corporate PC users already have expressed concern about the memory requirements of OS/2 Standard Edition. IBM has used a classic strategic weapon for Extended Edition: if you have to ask how much memory it needs, you can't afford it. Like its user interfaces, Extended Edition's hardware requirements are closer to the mainframe world than a low-cost PC configuration.

With its array of current and planned features, it comes as no surprise that Extended Edition is fond of high-powered hardware. Although advertised to run on the IBM PC/AT, XT/286, and PS/2 models with 286 or 386 microprocessors, 3MB of RAM, and a 20MB hard disk, in practice the minimum system is a PS/2 Model 50Z with 4MB of RAM and a 30MB hard disk. Most developers will prefer even more—a PS/2 Model 70 or 80.

Like all OS/2 configurations, Extended Edition is hardware specific and not likely to work on most compatibles (although *PC Tech Journal*'s tests indicate that it works on the Compaq Deskpro 386). In fact, the use of non-IBM communications boards is not supported even in IBM PCs.

If you are a true-blue corporate customer, these heavy-duty hardware requirements may not matter. Although other vendors are likely to offer attractive alternatives to the database portions of the product, many users, particularly those who have IBM communications boards, will prefer IBM's communications software. Who else, besides IBM, really understands SNA?

Will Extended Edition exceed the sum of its parts? Will it foster the development of corporate applications on PCs? The answer to the second question is likely to be yes. The answer to the first is a little more difficult.

Third-party vendors are going full-speed ahead with data manager and communications products for OS/2 that will likely perform as well as or better than those offered by IBM in Extended Edition. Moreover, Extended Edition is not yet a complete product. Its list of planned enhancements is nearly as long as its list of supported features. Nonetheless, it is the most complete package available now, and the most complete system likely to be available from any single vendor.

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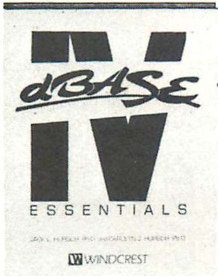

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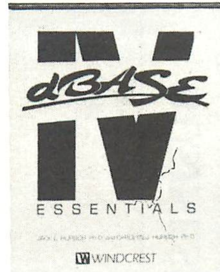

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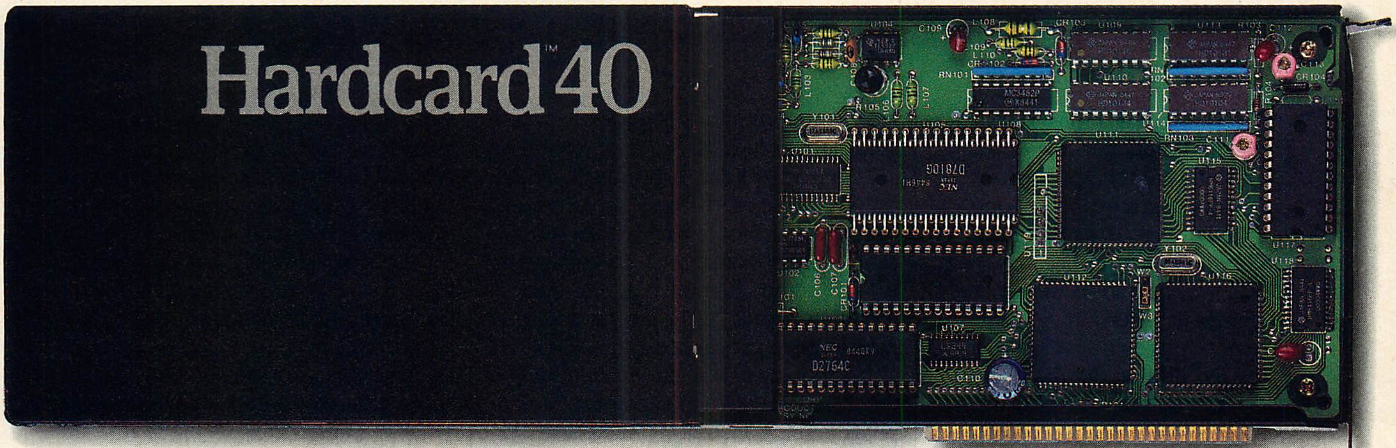

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Cooperative Communications

Communicating with the mainframe is essential for successful corporate applications on the PC. The OS/2 Communications Manager is IBM's first step toward that goal.

DENNIS LINNELL

OS/2's Communications Manager sets the foundation for developing sophisticated applications that perform cooperative processing between the PC and IBM's System/370 mainframe. It, along with Database Manager (also reviewed in this issue, "OS/2 Meets SQL," Herbert A. Edelstein, p. 62), are components of OS/2 Extended Edition. As the charter member of IBM's Systems Application Architecture (SAA), Extended Edition represents a solid step toward developing and running complex business applications on the PS/2.

Extended Edition is a work in progress, however. It is not the final answer to every organization's cooperative processing needs, but, then, IBM products seldom live up to their potential in the first release; they typically require a few years before reaching maturity.

IBM chose to develop the Communications Manager component of Extended Edition itself—rather than relying on Microsoft or another party—in an effort to maintain control of its wide-area network architecture, while gaining a toehold in the competitive microcomputer systems software market. Communications Manager is available only from IBM.

Extended Edition 1.0's Communications Manager, the version reviewed here, provides only basic telecommunications services for OS/2. Its services include terminal emulation, file transfer, client-server relationships, and peer-to-peer program conversations. It also supports IBM features including the 3270 data stream, server-requester programming interface (SRPI), advanced program-to-program communications (APPC), and asynchronous communications.

Extended Edition version 1.1 adds Token-Ring and IBM PC Network support to Communications Manager as well as cosmetic changes to the user interface. IBM has announced a long list of planned enhancements, but has not committed itself to any time schedule for many of them. Planned enhancements include 5250 terminal emulation, LAN gateway, and CCITTX.25 packet-switching network support.

All of these functions are already available under DOS. What is new, then, about Communications Manager? Aside from packaging and integration, Communications Manager benefits from OS/2's advanced features. Communications features in OS/2 are more accessible and better defined than in DOS. In OS/2, IBM provides consistent sets of application program interfaces (APIs) for each of the major communications protocols. Like the other OS/2 APIs, Communications Manager APIs can be called directly from any application. Because OS/2 provides a 16MB address space, larger applications are possible. Thus, the amount of memory available to an application is not constrained by the presence of the communications software as it is in DOS.

These improvements incur a price in terms of hardware. The communications software alone requires more than 5MB of hard-disk space. The OS/2 base operating system, including DOS compatibility, requires about 2MB of RAM. The Communications Manager base, which is continuously resident, needs about 200KB of RAM. Each concurrent function (such as APPC, 3270 emulation, asynchronous terminal emulation, and file transfer) requires an additional 300 to 400KB. Thus, with three concurrent communications functions, the operating system alone requires 3.4MB. On top of this, add the

Database Manager and Query Manager (another 2MB) and 1MB of application code. Reserve some memory for disk-caching software, which will be necessary to speed up I/O. The end result is that 8MB of RAM fills up very quickly.

Small applications require a minimum of 4MB of memory. In OS/2, running out of memory is not the catastrophe it is in DOS. OS/2's virtual memory architecture allows the sum of the memory requirements of applications to exceed the total installed RAM. When this occurs, the system swaps segments between RAM and the hard disk. With OS/2, the good news is that you can run the application, even though it is bigger than your machine. The bad news is that it might run quite slowly. For many communications applications, slow execution is not acceptable and ample memory is essential.

Certainly, few, if any, major corporations are implementing OS/2 on every desktop today. DOS still offers the right size and functionality for the majority of its current users. OS/2's architecture, however, is nearly ideal for applications acting as servers, especially those performing communications. Client applications could run under DOS on a LAN and communicate with a server that is running under OS/2. In turn, the server communicates with the mainframe. In the short term, this is the most practical scenario for using Communications Manager.

SIMPLY SERIAL

The PC inspired a strong interest in asynchronous communications within the IBM world. Unlike previous IBM products, the PC had a good asynchronous implementation that was relatively easy to program. Many third-party vendors developed PC asynchronous terminal emulators, such as DCA's Crosstalk, Hayes's Smartcom, and Datastorm's PROCOMM PLUS. Users immediately demanded better asynchronous connectivity to IBM mainframes. IBM fulfilled this need primarily through synchronous-to-asynchronous protocol converters such as the 3708 and 7171. By the mid-1980s, IBM had substantially improved its support of asynchronous communications.

The Communications Manager asynchronous implementation is structured into two parts: the Asynchronous Communications Device Interface (ACDI) and ASCII Terminal Emulation. Any program that wants to use serial ports in the OS/2 multitasking environment can use the ACDI API. In effect, the API creates an asynchronous communications subsystem, which executes as an OS/2 process. This subsystem interacts with the serial ports through the operating system and ensures that interrupts are handled and data are buffered on behalf of the applications.

ACDI contains command verbs that permit the user to send and receive data through serial ports as well as to set the bit rate, word length, and flow-control parameters (see table 1). Thus, developers can write applications that use asynchronous protocols without having detailed knowledge of the underlying hardware. The applications can be written in C, Pascal, or assembly language. ACDI also insulates the developer from changes in the operating system, hardware, and device drivers.

Because ACDI is an extension of the operating system, several applications can access it simultaneously. Although applications cannot share a single communications port, an application can temporarily relinquish control of the port—while waiting, for example, for a host computer to call back.

ILLUSTRATION • CARY HENRIE

TABLE 1: ***ACDI Application Program Interface Verbs***

VERB	DESCRIPTION
ComClose	Closes specified communications device.
ComDefInput	Defines input buffer and input mode.
ComDefOutputBuff	Defines application output buffer.
ComDisconnect	Disconnects asynchronous communications connection.
ComDrainOutput	Blocks thread until transmit buffer is emptied.
ComFlushInput	Clears the application input buffer.
ComFlushOutput	Clears the application output buffer.
ComGetLineInfo	Returns RS-232 signal status.
ComOpen	Opens communications device for an application.
ComReadBlock	Reads block of data and frees block from previous read.
ComReadCharString	Reads character string and frees memory from previous read.
ComReadEvent	Enables the communications event queue.
ComRetBitRate	Returns bit rate for which the hardware is programmed.
ComRetErrorCharSub	Returns current error substitution character and mode.
ComRetFlowChar	Returns XON/XOFF characters used for flow control.
ComRetFlowMode	Indicates whether automatic flow control is enabled.
ComRetFlowThresh	Returns flow control threshold levels for input buffer.
ComRetLineCtrl	Returns current values for stop bits, parity, and data bits.
ComRetTimeout	Returns timeout values for read/write verbs.
ComSendBreak	Sends break signal for user-specified duration.
ComSetBitRate	Sets hardware bit rate.
ComSetErrorCharSub	Sets error substitution character and mode.
ComSetFlowChar	Sets flow control (XON/XOFF) characters.
ComSetFlowMode	Turns flow control on or off.
ComSetFlowThresh	Sets flow control threshold for application input buffer.
ComSetLineCtrl	Sets stop bits, parity, and data bits in hardware.
ComSetTimeout	Sets timeout values for read/write verbs.
ComStartTrans	Starts transmitting data from the output buffer.
ComStopTrans	Stops transmitting data.
ComTransImm	Sends the specified character immediately.
ComUnblockThread	Unblocks the specified thread, if it is currently blocked.
ComWriteCharString	Writes data from the application output buffer.

The user controls asynchronous communications functions using the ACDI API; high-level languages, such as C, can call the functions. Communications Manager has no scripting or interpretive languages, a serious limitation for many users.

ACDI supports concurrent use of three ports on the PS/2.

The Communications Manager's ASCII Terminal Emulation component uses ACDI services to make the workstation act like an IBM 3101 Model 20 or a DEC VT-100 terminal. It communicates via an asynchronous link, which the user can switch, lease, or directly attach, and is compatible with 1984 CCITT V.24/V.28 (equivalent to RS-232). It works with a variety of modems, including those using the Hayes AT and CCITT V.25-*bis* command sets.

Although multiple asynchronous sessions are possible, only one ASCII terminal emulation can be active at a time. Terminal emulation file transfers use the same OS/2 screen group. Hence, the system does not accept simultaneous asynchronous file transfers. Three types of asynchronous file transfers are possible: send ASCII text, XMODEM, and IBM-host file transfer.

The Send ASCII Text File function simply sends the contents of a file to the remote system—for example, for uploading a document to an electronic mail system such as MCI Mail. The user establishes a connection with the remote system, selects the "send ASCII text file" function from the terminal operations menu, and specifies the file name. The system displays the file name during transmission. The Data Capture function receives files.

XMODEM seldom is used to communicate with IBM mainframes but is a frequently used protocol for transferring files between PCs. The user initiates XMODEM transfers from the main menu of Communications Manager. The protocol transfers files to or from any other computer that supports the protocol, whether it is a non-IBM system or another system running Communications Manager. The other system must be running a compatible file-transfer program at the time the transmission is requested.

Communications Manager supports the 3270-PC IND$FILE file-transfer protocol. Though used primarily in conjunction with 3270 terminal emulation, it can be used with 3101 emulation and a suitable protocol converter. IND$FILE is compatible with both MVS/TSO and VM/CMS operating systems and requires the host to run the IBM 3270-PC File Transfer Program. The user initiates file transfer from the OS/2 command line with the SEND or RECEIVE command. These commands are nearly identical to those used by the IBM 3270 emulators under DOS.

MAINLY MAINFRAMES

The IBM 3270 terminal family is ubiquitous within the IBM mainframe world. PC emulation of 3270 display terminals and printers has been commonplace for about five years. IBM and

many competitors offer 3270 connectivity products with a wide range of functions and configurations. Communications Manager contains the OS/2 equivalent of IBM's DOS-based 3270 emulators. The DOS-based emulators include the IBM PC 3270 Emulation version 3.0, 3270 Workstation Program version 1.1, and 3270 Emulation Program Entry Level version 1.2.

The 3270 product line contains display terminals and printers that are connected to cluster controllers. Communications Manager emulates the most common 3270 display terminal models: 3178 model 2, 3278 models 2 through 5, and 3279 models S2A and S2B. These terminals typically are connected to either an IBM 3174 or 3274 cluster controller. The 3174 is the newer and more powerful model.

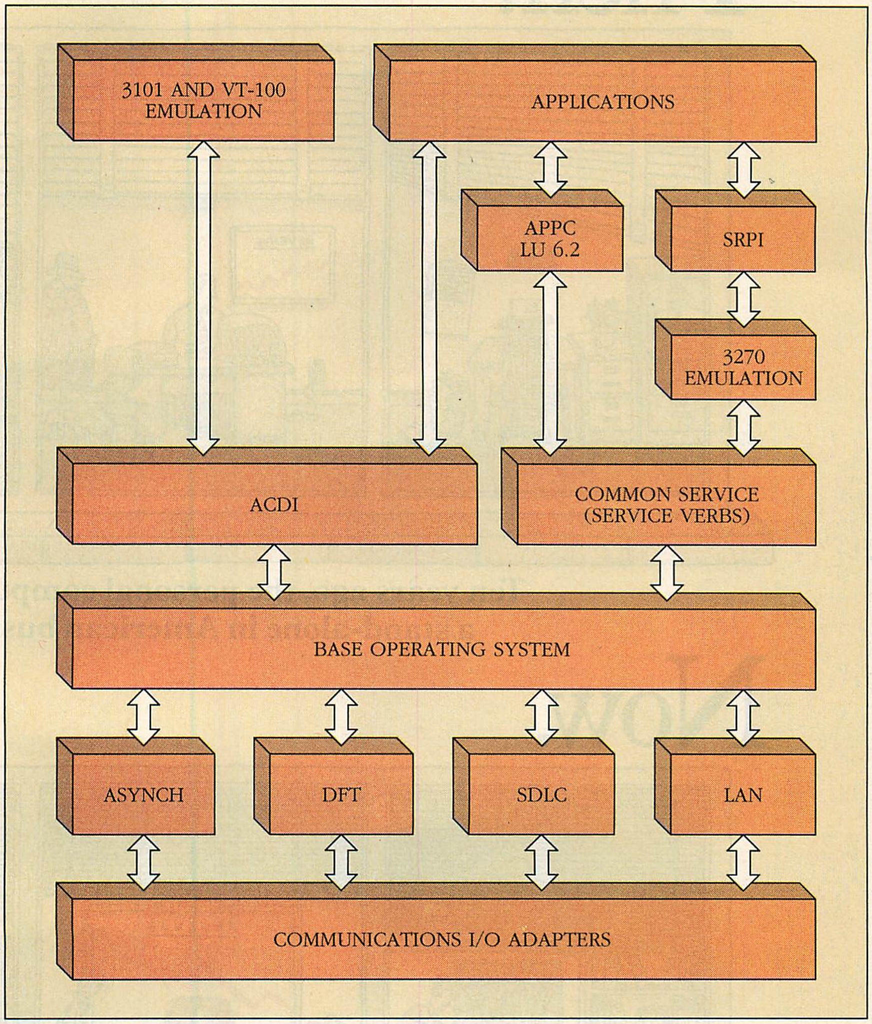
The cluster controllers are connected directly to System/370 mainframes via I/O channels or via a network to a communications controller (or front-end processor) such as an IBM 3720, 3725, or 3745. The connection from the cluster controller to the communications controller typically is a data link using synchronous data link control (SDLC) protocols, but it also could be a packet data network using both CCITT X.25 and Systems Network Architecture (SNA) protocols.

Cluster controllers connect to terminals either directly through cables or through an IBM Token-Ring LAN. The wiring for the direct connection varies, but often uses coaxial cable or the IBM cabling system. Two interfaces exist for this connection: Control Unit Terminal (CUT) mode, which is used with dumb terminals, and Distributed Function Terminal (DFT) mode, which allows five concurrent sessions to run on a single cable.

The 3270 data stream defines the data and commands for controlling and formatting information on IBM 3270 display terminals and printers. It offers two levels of functionality: base data stream, which defines simple screen formatting, and extended data stream, which offers seven colors and extended highlighting. Communications Manager supports both base and extended data streams. In an SNA network, 3270 display terminals use logical unit (LU) type 2 session protocols.

Communications Manager supports three types of 3270 connections (see figure 1). Because it is so commonly used already, the most popular probably will turn out to be a direct cable connecting the workstation to a cluster controller. This controller may be a 3174 or 3274 connected to the host by either an I/O channel or a data link. In this configuration, the cluster controller need not support SNA, and thus may be binary synchronous (bisynchronous) or channel-attached. The connection between the workstation and the cluster controller operates in DFT mode, thereby allowing multiple concurrent sessions.

FIGURE 1: ***Communications Services Hierarchy***



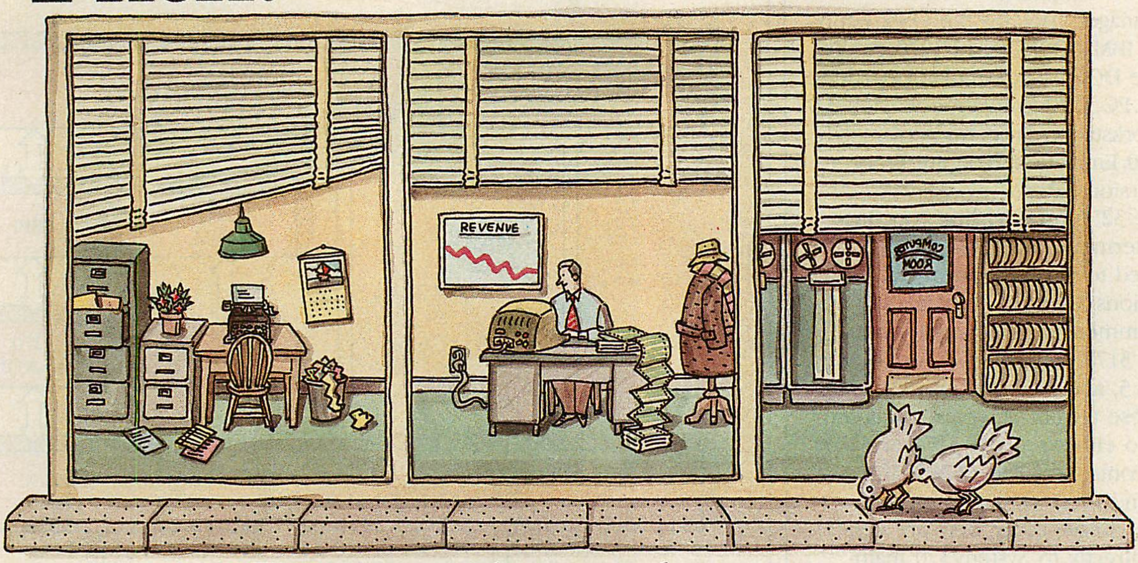
Communications Manager permits users and applications to access networks without interacting with communications adapters. Version 1.1 supports LAN as well as asynchronous, 3270-DFT, and SDLC communications.

Alternatively, Communications Manager emulates an SNA cluster controller and connects to the host via an SDLC link and synchronous modems. In this case, the workstation acts as a combined cluster controller and terminal. In SNA terminology, the workstation is called a type 2 node, or physical unit (PU) type 2. With this configuration, a single SDLC link can carry five sessions. Moreover, a single workstation can support one SDLC link plus one direct DFT connection simultaneously, thus allowing 10 sessions to run concurrently.

In Extended Edition version 1.1, Communications Manager connects through the LAN to a Token-Ring adapter of a 3174, 3720, 3725, or 3745 controller or an IBM 9370 computer. Each of these machines acts as a gateway from the Token-Ring LAN to the SNA wide area network. The LAN can support five concurrent sessions per workstation. This configuration has the potential for very good performance because of the high-speed communications possible over a LAN.

A future version of Communications Manager will act as a gateway between a LAN and the host system. PS/2s running OS/2 Extended Edition will communicate across the LAN to the gateway; the gateway will communicate with the host using SNA/SDLC or SNA/X.25 protocols. The functions of the

Then.



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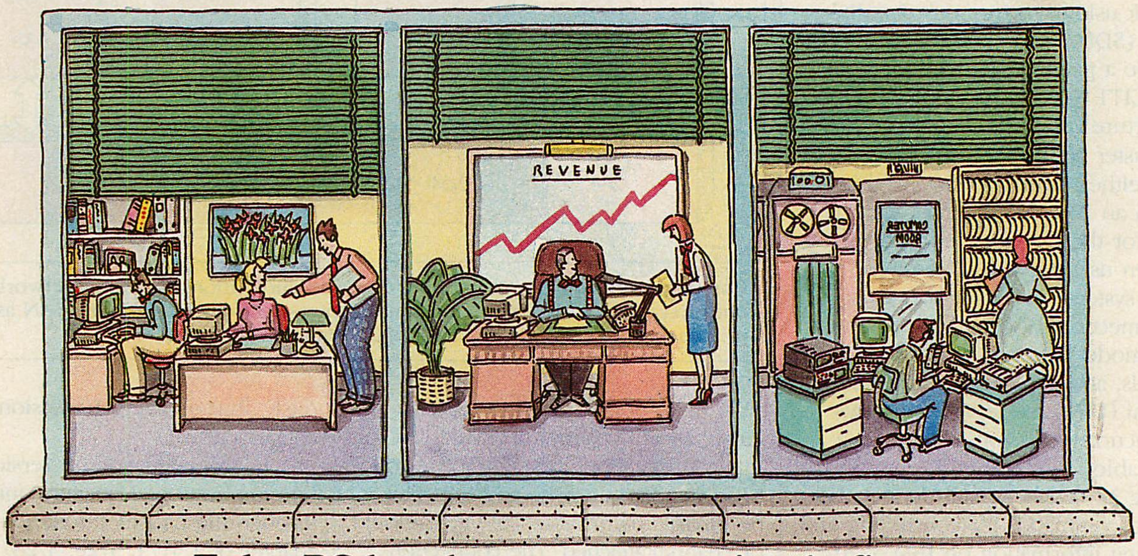

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gateway essentially will be transparent to the user at the workstation. This gateway will support both 3270 (LU 2) and APPC (LU 6.2) sessions.

Anyone who has ever used any of IBM's 3270 emulators will immediately understand the usefulness of the keyboard remapping feature of Communications Manager's 3270 emulator, which redefines the default keyboard layout in the 3270 session. This facility allows key swapping, key disabling, and assignment of a string of keystrokes to a single key. The user can define multiple keyboard profiles, but only one can be active at a time and it applies to all active 3270 sessions. Typing with IBM's default keyboard mapping is more challenging than playing a Liszt sonata on the piano. It gives new meaning to the term "chord." A user is almost obligated to redefine the keyboard, but no one standard redefinition works for everyone.

Communications Manager performs several other 3270 functions, including file transfer and Emulator High-level Language API (EHLLAPI). The user can initiate file transfer in two ways: from the OS/2 command line using the SEND and RECEIVE commands or from the Communications Manager main menu. The user can create a file-transfer profile during Communications Manager installation or at the time of transmission. The profile specifies options such as ASCII/EBCDIC translation, code pages on the host and PC, the name of the file-transfer program, file attributes, and disk-space allocations on the host.

EHLLAPI, provided in Communications Manager 1.1, permits applications to control an active 3270 session. In effect, EHLLAPI substitutes a program for a human terminal operator in order to simplify the interaction between the end user and a host-based application. The EHLLAPI interface is compatible with Entry Emulator HLLAPI (EEHLLAPI), which is used in the PC 3270 Emulator Program, Entry Level, version 1.2 (see "The High Road to Host Connectivity," Michael Triner, January 1989, p. 84).

PEER TO PEER

Unlike 3270 protocols, which define communications between terminals and mainframe hosts, APPC governs peer-to-peer communications between cooperative programs, whether running on mainframes, minis, or micros. APPC facilitates communications between cooperating programs using SNA LU 6.2 protocols. APPC defines a set of verbs that enables conversations between pairs of applications. It is a single architecture that spans the entire IBM spectrum from PCs to the largest System/370 mainframes, allowing communications between programs located on any machine in the network. APPC is the foundation for developing sophisticated cooperative-processing applications.

LU 6.2 is available in all systems supporting SAA and thus is highly strategic for IBM. It is the communications base for electronic mail, distributed database, and advanced printing functions. Under DOS, APPC/PC provides LU 6.2; on System/370 mainframes, CICS and VTAM version 3.2 support the protocol under MVS, and APPC/VM and Transparent Systems Access Facility (TSAF) support it under VM. Although available on many non-IBM computer systems and supported in many operating system environments, few applications now use APPC directly.

Anyone who has ever used IBM's 3270 emulators will immediately understand the usefulness of the keyboard remapping feature.

APPC supports a variety of data links, including SDLC, X.25, and the Token-Ring LAN. The protocol is designed to use network resources efficiently, permit programming in high-level languages, and insulate the application from the technical details of the network. Unlike other SNA session protocols, APPC has a standardized interface, called the protocol boundary, which is designed to be consistent across IBM product lines.

APPC has two styles of conversations: basic and mapped. Basic conversations have access to the full set of LU 6.2 features and are used by privileged programs written in low-level languages. Basic conversations exchange data records directly, without translation or mapping. Mapped conversations are intended for programs written in higher-level languages; they hide some of the details of the protocol and ensure that the programs comply with certain protocol rules. Mapped conversations exchange information using the General Data Stream (GDS), which maps the data from one format to another—conversion from ASCII to EBCDIC, for example.

SNA node type 2.1, also called low-entry networking (LEN), supports peer-to-peer communications. Directly connected type 2.1 nodes can establish multiple and parallel SNA sessions. Thus, applications residing in different LEN nodes can communicate directly using LU 6.2 or other SNA session protocols. Until recently, type 2.1 nodes have been treated as type 2 nodes in mainframe SNA networks. Beginning with VTAM version 3.2, LEN nodes can operate in a peer-to-peer mode in large networks.

Both APPC and LEN are included in Communications Manager. The operation of LEN is transparent to the developer, but APPC has an elaborate API, which can be used by programs written in C, Pascal, and assembly language. The APPC implementation in Communications Manager is greatly improved over DOS's APPC/PC. In DOS, a developer has to build a parameter block and issue an INT 68H, which is unnatural in high-level languages. In OS/2, APPC verbs are issued using a standard API call, passing the address of the parameter block.

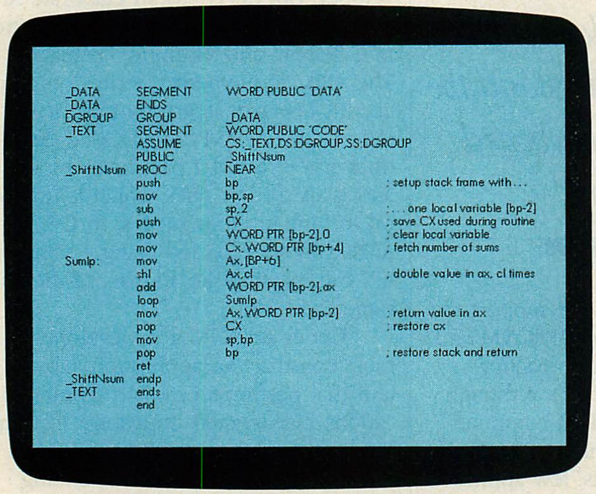
Under APPC/PC, the developer must construct an application subsystem that performs extensive communications management functions. In Communications Manager, this function is handled by the OS/2 base operating system. Details related to the node configuration are no longer embedded in the application; Communications Manager menus, for example, handle physical-unit definition. Moreover, user exits included in APPC/PC are no longer available. Hence, migration from APPC/PC to Communications Manager might require substantial changes in applications. Fortunately, APPC/PC is not widely used.

In a future version, Communications Manager will provide a gateway function that will allow APPC sessions to pass transparently from LANs though the SNA wide area network to System/370 hosts. This is the same gateway that will support 3270 protocols. This missing piece is essential for the development of cooperative-processing applications running on both OS/2-based servers and workstations.

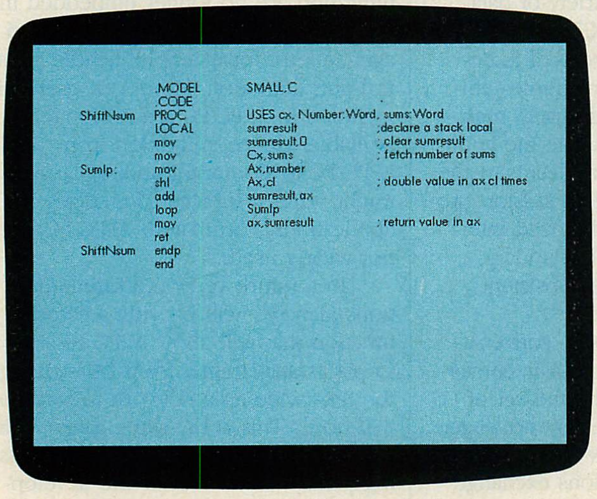
SERVER SERVICE

A considerably simpler protocol than APPC, SRPI also provides connectivity between programs running on different machines. SRPI's focus is much narrower than APPC's, in several respects.

Our new MASM 5.1 gives you two things you've never had in a macro assembler. MS OS/2 and spare time.



The old way: slow, cumbersome coding.



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Mixed-Language Programming Support and Documentation
- Mixed-Language Programming Guide with step-by-step examples.
- MASM templates for interfacing to BASIC, C, FORTRAN, and Pascal.
- Sample macros for interfacing for DOS and OS/2 systems. NEW!
- Simplified segment directives make writing MASM subroutines easy.
- Comprehensive instruction set *reference* with examples.
- Programmer's Guide – complete guide to MASM features and instruction set.

Macro Assembler for MS OS/2 and MS-DOS
- Full MS OS/2 support to break the 640K barrier. NEW!
- Supports the 80386 and 80387 instruction set.
- Assembles 25-40% faster than MASM 4.0.
- Have labels local to a procedure. NEW!
- Declare stack based local variables within a procedure. NEW!
- OS/2 systems incremental linker – up to 20 times faster than a full link. NEW!

Microsoft CodeView Window-Oriented Debugger and Microsoft Editor
- Full OS/2 systems support. NEW!
- Debug MASM code using original source code with your comments.
- Interactively view structures and chase linked lists. NEW!
- Take advantage of the 80386.
- Set dynamic breakpoints, watch variables, memory, registers and flags.
- MS OS/2 and MS-DOS reconfigurable programmer's editor. NEW!

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TABLE 2: ***Extended Edition Documentation***

ORDER NUMBER	PUBLICATION
90X7447	IBM OS/2 Extended Edition, Getting Started
90X7446	IBM OS/2 Extended Edition, User's Guide
90X7452	IBM OS/2 Extended Edition, User's Reference
90X7946	IBM OS/2 Extended Edition, Problem Determination Guide
90X7947	IBM OS/2 Extended Edition, ACDI Programming Reference
90X7950	IBM OS/2 Extended Edition, APPC Programming Reference
90X7949	IBM OS/2 Extended Edition, ECF Server-Requester Programming Reference
90X7951	IBM OS/2 Extended Edition, Problem Determination for Communications
GC26-4341	IBM Systems Application Architecture Overview
SC26-4351	IBM SAA Common User Access Panel Design and User Interaction
SC26-4362	IBM SAA: Writing Applications, A Design Guide
SC26-4399	IBM SAA Common Programming Interface Communications Reference
GC30-3073	SNA Technical Overview
GA27-3136	IBM Systems Network Architecture Formats
SC30-3269	SNA Formats and Protocols, Architecture Logic for LU 6.2
SC30-3422	SNA Formats and Protocols, Architecture Logic for type 2.1 nodes
G320-0369	CICS/VS 3270-PC File Transfer Program (information about IND$FILE)

Extended Edition developers need a variety of manuals; only the first three listed above are included with the operating system. Users of Extended Edition applications do not need manuals describing the SAA and SNA communications architectures.

First, it supports only the PC and System/370 MVS/TSO and VM/CMS environments. Second, SRPI has fewer features than APPC—for example, it supports only two verbs (SEND_REQUEST and SEND_REPLY). Finally, SRPI subscribes to the server-client model, with the restriction that mainframe applications must be servers, and PC applications must be clients.

The SRPI protocol is part of a larger family of IBM resource-sharing and data-exchange services, called the Enhanced Connectivity Facilities (ECF). ECF, which contains a set of IBM-developed requesters for the PC and servers for the mainframe, facilitates IBM Database 2 (DB2) and Structured Query Language/Data System (SQL/DS) data access from the PC, data conversion to several popular PC formats (such as virtual disk, file, and printer), file transfer, and execution of mainframe host commands from the PC.

Under DOS, IBM includes SRPI in the IBM 3270 Emulation Program version 3 or the 3270-PC Control Program version 3. On the mainframe, IBM provides SRPI in MVS TSO/E release 3 or VM/SP release 4.

As implemented in Communications Manager, SRPI allows an OS/2 application to act as a requester. The user issues requests through the SEND_REQUEST verb, which is nearly identical to the current DOS implementation. The existing SRPI software in TSO/E and VM/SP is compatible with the OS/2 SRPI.

Any OS/2 application may call SRPI. The application specifies a server name, which is used by the operating system to route the request to the appropriate 3270 session. This routing is defined in advance by one of Communications Manager's profiles. Before using SRPI, the user must establish a link to the CMS or TSO server program using a 3270 session, which cannot be used for any other purpose while SRPI is active. As an extension of the operating system, SRPI is available to multiple applications concurrently. Because each 3270 session can handle only one call at a time, Communications Manager queues and services additional callers sequentially.

Although SRPI currently uses the 3270 data stream, IBM has announced it intends to use SNA LU 6.2 as a transport mechanism for SRPI in the future. This will be much cleaner from an architectural perspective and may simplify the design of cooperative applications. SRPI, however, cannot provide the full power of APPC's verb sets and is supported only on the PC and System/370.

COMPLEX CONFIGURATIONS

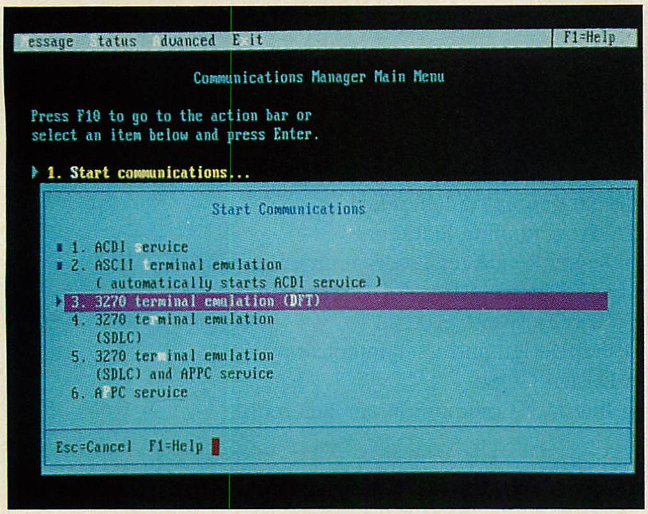
Extended Edition's menu-driven setup program is quite straightforward and is divided into three separate processes: installation of the base OS/2 operating system, which is mandatory, and installation of the Communications Manager and Database Manager components, both of which are optional.

The *Getting Started* manual contains a step-by-step procedure for installing Extended Edition but does not include directions for specifying communications parameters. It does provide detailed instructions, however, for installing the OS/2 device drivers needed for communications. (For a complete list of Extended Edition documentation, see table 2.)

Although installation is uncomplicated, configuration has some unusual features. The first surprise comes when configuring the device drivers. On an AT-bus computer, the SDLC driver cannot be used at the same time as either the MOUSE*xxx*.SYS driver or the ASYNCDDA.SYS driver. This hardware-related restriction limits the usefulness of SDLC connections, because they cannot operate concurrently with asynchronous communications or with applications requiring a mouse. The suggested solution is to switch between CONFIG.SYS files and reboot whenever the user needs the mouse or to conduct asynchronous communications. The SDLC driver for Micro Channel systems has a parameter to share an interrupt level with other devices controlled by Communications Manager.

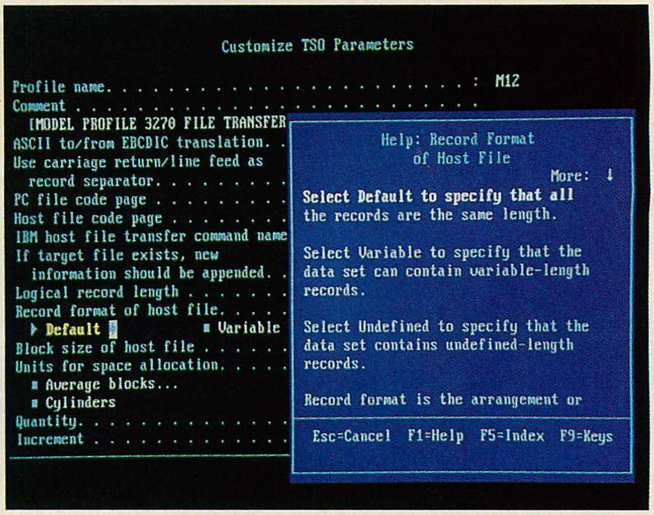
Communications Manager is activated from a selection on the OS/2 main menu; the user then controls communications services using a series of menus (see photo 1). Communications Manager uses a different OS/2 screen group for each protocol family (such as asynchronous, 3270, and

PHOTO 1: ***Starting Communications***



The Communications Manager main menu is used to start and stop all communications. The user controls each protocol by selecting from its own pop-up menu.

PHOTO 2: ***File-transfer Options***



The user can specify numerous host and PC file format and communications options when transferring files. Default values and on-line help information are provided.

APPC) plus a screen group for overall control. The user moves between screen groups using the Alt-Esc key combination; the Alt-PgUp key combination switches between 3270 host terminal sessions.

The first-time user will probably want to start out with a simple task, such as IBM 3101 asynchronous terminal emulation. With a standard asynchronous modem connected to the serial port and the command

DEVICE=C:\CMLIB\ASYNCDDA.SYS COM1

in CONFIG.SYS, the user can start Communications Manager from the program selector screen.

During initialization, Communications Manager requires a parameter that indicates the configuration file to be used. The default value may be specified during the installation process. Because the parameter is included in the OS/2 application selector's list of applications, the user can change it at any time. If the default is blank, OS/2 displays a pop-up menu that asks the user for the parameter. Anyone who uses multiple communications configurations (for example, both asynchronous and 3270 terminal emulation), probably will want to configure the Communications Manager to display this pop-up menu.

After starting Communications Manager, the Parameter Information pop-up menu appears. The untrained user will have no idea what information this cryptic menu is requesting. Help, available by pressing the F1 key, indicates that the parameter is optional. If, however, the user starts Communications Manager with no parameter, it fails to operate. The manual says that the parameter is the name of the configuration file (without the .CFG extension) in the \CMLIB directory. Fortunately, IBM has provided some sample configuration files, and IBM 3101 emulation is included among them.

Specifying "IBM3101" in the Parameter Information pop-up menu initializes Communications Manager. The main menu contains the option to start communications, which the user selects by moving the selection cursor to the appropriate screen location and pressing the Enter key. Next, a pop-up menu labeled Specify ASCII Terminal Emulation Profile Name appears. The F4 key displays a list of valid profiles.

IBM provides a profile called A1 that allows communications to an IBM host with a 3710 protocol converter (the 3710 is no longer manufactured, but many are still in operation). If the user selects A1, a pop-up menu titled Specify Strings for Auto-Dial appears. The user types in the telephone number in this menu and presses the Enter key to access the 3101 emulation screen where commands to the modem are executed.

While the pop-up menus are not elegant at first glance, the user may eventually appreciate their subtle charm. If not, the user can preconfigure most parameters automatically to bypass most of the menus. On the menu bar of the main menu, the Advanced selection leads the user into the labyrinth of configuration menus that allows automatic specification of a myriad technical details. The manual warns the novice not to wander into this area; security features permit the system administrator to discourage tinkering by the curious.

OS/2 and DOS applications can execute concurrently with the terminal-emulation session. The usual Ctrl-Esc key combination returns the user to the program-selector menu. Two entries appear on the menu: one for Communications Manager itself and the other for terminal emulation. The user must select the terminal-emulation screen group to return to the host session, but may select the Communications Manager option to start another session or to terminate the session in progress.

It is possible for a communications expert to use IBM 3101 emulation with the manuals supplied. IBM 3270 emulation with SDLC, however, is considerably more difficult. Not only does SDLC 3270 emulation require a few additional manuals (which must be ordered separately), but it also usually requires changes in VTAM parameters on the mainframe. For example, the Communications Manager SDLC XID (exchange ID) machine-type code is different from its DOS predecessors. Close coordination with a mainframe communications-systems programmer is a virtual necessity.

Configuring SDLC 3270 terminal emulation is similar to IBM 3101 emulation, except that IBM does not supply sample parameters as a starting point. This requires someone (typically, *not*

the end user) to navigate through the menus and specify all the communications parameters. An expert can accomplish this in about 15 minutes. A novice should not even attempt it, because the *System Administrator's Guide for Communications* manual is filled with jargon and irrelevant details.

The user can transfer files with both asynchronous and 3270 protocols using default values or parameters that are specified at the time of the transfer. As is generally the case, on-line help information is available for any menu item to be completed (see photo 2), although information about Communications Manager's many error codes is available only from the appropriate reference manuals.

Probably the most difficult configuration to set up in Communications Manager is APPC communications with SDLC. Fortunately, APPC under OS/2 is vastly simpler to use than APPC/PC under DOS. Configuring 3270 emulation with DFT, which requires a 3270 Emulation Card connected to an IBM 3174 or 3274 cluster controller, is also fairly simple. IBM further assists the installer by providing several sample configurations for this popular option.

Once the developer or systems administrator sets up any applications in Communications Manager, an end user with limited training can easily operate the system. The terminal-emulation functions work in a manner similar to IBM's DOS-based terminal emulators. Communications Manager offers major improvements over DOS because the terminal emulation functions do not substantially reduce the memory available to applications running in either OS/2 mode or DOS compatibility mode.

PROMISES, PROMISES

Perhaps the biggest lure of Extended Edition is the promise of future enhancements. Indeed, the vaporware factory has been spouting clouds of blue smoke about improvements for the future. At the same time, these enhancements are the biggest frustration—particularly because IBM has not announced any delivery dates.

Extended Edition 1.0 contains all the major Communications Manager functions except for LAN support. Version 1.1 contains LAN requester support, which is equivalent to the IBM LAN Support Program available under DOS. To make full use of the Token-Ring LAN, a customer must also order, at extra-cost, the IBM OS/2 LAN Server program.

Beyond version 1.1, IBM has promised several enhancements for Communications Manager. First, and perhaps the most interesting, is the SNA LAN gateway. This feature will permit multiple 3270, SRPI, or APPC connections between workstations and host applications to pass through the OS/2-based gateway. The workstations can be running either OS/2 or DOS. Each gateway will support as many as 254 LUs, and each workstation on the LAN can have four active sessions. The gateway does not need to be dedicated to communications; with sufficient capacity, it can act as a file server or application processor.

The vaporware factory has been spouting clouds of blue smoke about future improvements for Communications Manager.

IBM promises to support CCITT X.25 packet switching using two complementary approaches. The company will add an API to OS/2 that contains the full set of X.25 DTE (data-terminal equipment) functions to support non-SNA connections. The second approach is the Qualified Logical Link Control (QLLC) protocols defined by IBM, which will provide full SNA support.

While the initial release of Communications Manager offers complete emulation of 3270 terminals, it ignores the 5250 terminal family, which has been popular on IBM System/36s, /38s, and other products. IBM plans to add a 5250 workstation feature that will emulate five print and display sessions through APPC protocols. Display sessions will emulate the 5292-1 and 3197-C20 terminals. Emulated printers include the 5219, 5224, and 5256. Connectivity to the System/36 will be supported via SDLC, Token-Ring, and X.25. In addition to these, the AS/400 will support connections via twin-axial cable and the IBM 5394 remote control unit. The programming interface will be EHLLAPI, which will be identical to 3270 emulation.

IBM plans to enhance the 3270 data stream to support double byte character set (DBCS) language translation. DBCS is included under SAA's Common User Access (CUA) component. SAA specifies rules for supporting languages other than English, including those in which writing is performed right to left. IBM set up DBCS to handle languages that do not have Latin characters, including Japanese (Kanji), Korean, and Chinese.

An enhanced SRPI also will be able to route requests over an LU 6.2 link to the appropriate server. The interface will be fully compatible with the SAA communications interface. To promote compatibility with existing configurations, SRPI will continue to support 3270 (LU 2) connections.

CONSERVATIVE COMMUNICATIONS

Communications Manager is a testament to the evolutionary nature of IBM products. It contains no startling new technology, but it does improve on existing technology.

In the area of asynchronous terminal emulation, Communications Manager's design is not very elegant. ACDI, in particular, is an example of an inherently simple problem that is made unnecessarily complex. IBM certainly could learn from the competition, especially in the areas of software ergonomics and flexibility. The lack of a communications script function, which is available in the most rudimentary products, is inexcusable.

For the primary IBM communications architectures, including APPC, SRPI, and 3270, Communications Manager offers a reasonably complete set of features. The combination of features provided is unsurpassed by any other available product. IBM's OS/2 offering has fewer restrictions and several important improvements over the equivalent DOS products. Furthermore, a customer can be certain that IBM's products will support the latest SNA features sooner than its competitors.

Communications Manager will appeal to a relatively small audience. Those who see a need for most of its current and planned functions will not likely find a better third-party implementation. It also will be of interest to 3270 communications users and is a requirement for those who want to use IBM's OS/2 LAN support (IBM's OS/2 LAN requester functions are included only in Extended Edition). Certainly, Communications Manager is not for those who are just looking for asynchronous communications.

Dennis Linnell is president of Gate Technology Inc., a consulting and software development firm in McLean, Virginia. He specializes in IBM systems architecture.

OS/2 Meets SQL

If you know and love IBM's DB2 or SQL/DS on the mainframe, you will know and love the OS/2 Database Manager. It carries the world of IBM mainframe data management to the PC.

HERBERT A. EDELSTEIN

IBM's OS/2 Extended Edition 1.0 Database Manager brings all of the best and worst features of mainframe data managers to the PC. Its Database Manager runs on a powerful mainframe-like database engine called Database Services, but its Query Manager user interface is lackluster at best, resembling the Query Management Facility (QMF) on the mainframe without Query-By-Example (QBE) interactive query facility.

IBM's goal with Extended Edition is to deliver a complete multitasking operating environment that provides communications and database management in one package—and that also can become multiuser. Along with the Communications Manager, Database Manager provides users with the tools to integrate the PC into the corporate computing environment. (For an overview of OS/2 Extended Edition and a review of Communications Manager, see the first two articles in this cover suite, "The OS/2 Puzzle Takes Shape" and "Asynchronous and More," both by Dennis Linnell and which begin on pages 44 and 52, respectively.)

Beyond extending OS/2, Database Manager completes IBM's Structured Query Language (SQL) database-management product line across microcomputers, minicomputers, and mainframes. This PC product is nearly identical to its IBM mainframe brethren, DATABASE 2 (DB2) and SQL/Data Services (SQL/DS).

The prime target group for Database Manager is developers and users who already have DB2 or SQL/DS up and running. Database Manager allows them to develop applications on a micro and port them to a mainframe running DB2. In the future, when Database Manager becomes a true database server—a multiuser engine that coordinates requests from multiple applications and returns only requested data—it will compete with other database server products such as the SQL Server currently available from Ashton-Tate/Microsoft/Sybase.

Database Manager's SQL conforms to the Systems Application Architecture (SAA), IBM's standards to unite different hardware and software environments. SAA is a set of software interfaces, languages, and protocols designed to make applications transportable from the large 3090 mainframe to an AS/400 midrange to a PS/2 micro. (For a detailed handling of SAA, see "SAA: IBM's Road Map to the Future," Dennis Linnell, April 1988, p. 86.) SQL is part of the programming interface. The implementation vehicle for SQL is DB2 on Multiple Virtual Storage (MVS), SQL/DS on VM/CMS, and Database Manager under OS/2. Database Manager represents IBM's first attempt to make the SQL implementation—including query syntax, semantics, and error codes—in all these products identical.

As for the Database Manager user interface, Query Manager helps non-programmers retrieve data from the database using menu-based prompts to construct a query. The menus guide the user through defining a database, writing columnar reports, creating screens (panels), and developing most menu-based applications. Complex applications and reports require writing programs in a host language.

Database Manager is an SQL-based relational data manager. The relational model of database management was developed in the early 1970s at IBM's San Jose Research Laboratory by mathematician E. F. Codd; SQL was developed there by D. D. Chamberlin. (For a full overview of SQL, see "Lingua Franca

for Databases," Richard Finkelstein, December 1987, p. 52.)

Database Manager's Database Services engine has DB2-like capabilities for building large applications written in a host programming language. Database Services includes a precompiler to convert embedded SQL into code acceptable to the C/2 compiler, a binder to generate paths to the data for each SQL statement, configuration routines to set system parameters, and environment routines to create, delete, and recover databases.

Although Database Manager cannot be used by multiple users simultaneously because OS/2 is not yet multiuser, functions for concurrent access and transaction processing are already in place in the engine. Multiple tasks from different applications can run against multiple databases, but they can run only on the same machine. For example, a database loading task can run in the background while a user browses or updates the database.

Extended Edition 1.0 was evaluated for this review. Version 1.1 was examined just prior to this article going to press. The major addition to Data Services is a precompiler application programming interface (API) that developers use to create their own precompilers for translating SQL statements embedded in any OS/2 compiler programming language (such as COBOL and Pascal) into calls to Database Manager's Runtime Services. Query Manager has undergone only modest cosmetic changes, such as a Presentation Manager-like color scheme.

IBM plans to broaden the scope of Database Manager to encompass the client-server approach that is already part of Ashton-Tate/Microsoft/Sybase's SQL Server and many other products. In this model, front ends to the server—which include the user interface and application tools—can run on different computers connected to the server over a local area network (LAN). IBM intends to add Remote Data Services, which will enable multiple programs and front ends across a network using the OS/2 Communications Manager Advanced Program-to-Program Communications (APPC).

ARROW-STRAIGHT INSTALLATION

IBM delivers Database Manager on three 1.44MB 3.5-inch diskettes and provides straightforward instructions for its installation. After installing the base operating system, developers can install Database Manager in about 10 minutes using three quick commands that require no user input. DSINST installs Data Services, QMINST installs Query Manager, and SQLSAMPL installs a sample database that IBM ships with the product. Installation creates three directories: SQLLIB, which contains Database Manager in 5MB of disk space; SQLDBDIR to hold user-defined databases; and SQL00001, which contains the sample database in 500KB of disk space.

Data Services automatically creates a database configuration file with all parameters set to system defaults. Locklist sets the maximum storage for table and row locks; **buffpage**, the number of 4KB pages used for buffers; **maxfilop**, the maximum number of files for a database; **logfile**, disk storage size for a file recording all activity on a database; **softmax**, checkpoint time intervals for updating the log file; **maxappls**, the number of applications that can concurrently access the database; and **dlchktime**, a time interval for detecting deadlocks. To change defaults, the developer can select the Reconfigure op-

ILLUSTRATION • CARY HENRIE

tion from the Tools menu or call the UPDATE DATABASE configuration (SQLFEUDB) routine from a host-language program.

Database Manager's default profile specifies sign-on options, including a default authorization ID, database, and memory for retrieval of data; printing options such as lines per inch, width, and number of copies; and data-format options, such as a thousands separator for every three digits or rounding rules. Developers can change defaults and apply new profiles through Query Manager's Profile menu.

BEST OF RELATIONS

Although no commercially available data manager meets all 12 of Codd's rules describing relational data managers, table 1 shows that Database Manager comes close (also refer to the sidebar "What is Relational?" Richard Finkelstein, December 1987, p. 54).

Database Manager stores all data in tables, with each row an occurrence of a single entity and each column representing a characteristic of the occurrence. The contents of an order-entry database to test Database Manager includes the following tables (with abbreviations in parentheses where appropriate, as they appear in figure 1): customer, invoice (inv), line item (litem), and parts (part). Each column has a set of legitimate values, called the *domain*, from which each occurrence is taken. In figure 1, the domain for the state attribute column is the set of two-character abbreviations used by the U.S. Postal Service. If a data manager supports domains, the validation of a column's value is centralized in the data dictionary.

Like most PC relational data managers, Database Manager does not support domains, so developers must write a program to ensure that values entered for a column are part of the domain. For example, every table having a state column requires this code.

If two developers write data-entry routines that need validation, they both must write a routine to do it. No guarantee exists that they will handle validation in the same way; one, for example, may include the 50 states and the District of Columbia, and the other may add U.S. possessions and Canadian provinces. Because developers need write validation routines only once when a data manager supports domains, this can save time and money and ensure database consistency.

Database Manager does not support *primary keys* to ensure data integrity. Primary keys, unique identifiers for every row of a table, are made up of one or more columns, none of which can be null (a null value represents missing data). In Database Manager, the developer must specify a "not null" attribute to simulate primary keys and build a unique index on those columns in defining data. In figure 1, the primary key of the customer table is **cnum**, and the primary key of the line-item table is a combination of both **pnum** and **inum**. This is not consistent with DB2 syntax, which has an explicit primary key clause in the SQL CREATE TABLE command.

In addition, Database Manager does not handle referential integrity. In relational databases, referential integrity means that a change, such as an INSERT, to a *foreign key* (a column in one table that references a primary key in another table) also must occur in the primary key. To support foreign keys fully, the relational data manager must manage a deleted primary key row or changed primary key value. If the data dictionary does not do this, then the application developer again has to write code to do it. This, too, is a departure from DB2, which has a clause in the CREATE TABLE statement for referential integrity and the deletion of primary keys.

In OS/2 Database Manager, the CREATE TABLE command for the invoice table is similar to the following DB2 command except that the

TABLE 1: *Conformity to Codd's Rules*

RULE	ADHERENCE
1. Information	◐[a]
2. Guaranteed access	●
3. Systematic treatment of nulls	●
4. Active on-line catalog	●
5. Comprehensive data sublanguage	●
6. View updating	◐[b]
7. Table level update	●
8. Physical data independence	●
9. Logical data independence	●[c]
10. Integrity independence	○[d]
11. Distribution independence	○
12. Nonsubversion	●

● = Yes ○ = No ◐ = Partial

[a] No support of domains.
[b] Only row and column subsets of single tables can be updated.
[c] Limited by view updating.
[d] Lacks support for referential integrity.

Database Manager conforms fully to eight and partially to three of mathematician E. F. Codd's rules for measuring the relational nature of data managers. Like most available data managers, Database Manager cannot update multitable views; however, IBM promises support for referential integrity, domains, and primary keys—all supported in DB2—in a future, unspecified release of Database Manager.

FIGURE 1: *SQL Sample*

```
create table customer
    (cnum       char(5) not null,
     cname      char(30),
     street     char(25),
     city       char(15),
     state      char(10),
     zip        char(5))
create unique index ccnum on customer(cnum)

create table part
    (pnum       char(5) not null,
     pname      char(20),
     wt         decimal(7,2),
     qty        smallint,
     price      decimal(9,2),
     reord_qty  smallint,
     reord_lev  smallint)
create unique index ppnum on part(pnum)

create table inv
    (cnum       char(5) not null,
     inum       char(5) not null,
     odate      date,
     salespers  char(10),
     ddate      date,
     quarter    char(4))
create index iinum on inv(inum)
create index icnum on inv(cnum)

create table litem
    (pnum       char(5) not null,
     inum       char(5) not null,
     qty        smallint)
create unique index lpi on litem(pnum, inum)
create index lpnum on litem(pnum)
create index linum on litem(inum)
```

An order-entry database, consisting of customer, part, invoice, and line-item tables, was used to test Database Manager. Databases are defined using SQL Data Definition Language (DDL) statements, as shown here, or with Query Manager's prompted queries.

PRIMARY KEY and FOREIGN KEY clauses are not included:

```
CREATE TABLE  invoice
    (cnum      char(5),
     inum      char(5) not null,
     odate     date,
     sperson   char(10),
     ddate     date,
     qtr       char(4),
PRIMARY KEY (inum)
FOREIGN KEY (cnum) REFERENCES
  customer ON DELETE CASCADE)
```

Systems such as SQL Server use triggers to provide referential integrity, but store complex integrity conditions in the data dictionary. These products go beyond Database Manager to reduce programming and increase consistency.

Lack of support for domains and referential integrity in Database Manager means the database cannot protect itself from invalid updates entered using Query Manager and other interactive interfaces. Writing data-entry programs in a host language is the only way to ensure database integrity.

Database Manager compares with most PC SQL-based relational data managers in its conformance to Codd's rules. So far, under DOS or OS/2, only XDB Systems' XDB provides referential integrity and primary-key support (see "The XDB Dynamo," Randall Rustin, April 1988, p. 140). Based on IBM's commitment to consistency across its SQL products, IBM intends to add these features to Database Manager in a future release.

DB2-LIKE SQL

Developers and users define databases and access data using SQL. A high-level table-oriented language, SQL requires only the SELECT verb to retrieve data. However, the richness of SELECT can specify complex conditions in a few lines of code.

The American National Standards Institute (ANSI) standard for SQL is ANSI SQL I; proposed enhancements are called ANSI SQL II. ANSI I leaves out referential integrity, DROP TABLE and REVOKE privileges, and some other powerful SQL features. IBM's DB2 SQL is similar to ANSI I, but includes DROP TABLE, REVOKE, and physical storage commands.

The SQL in Database Manager reasonably conforms to DB2 (see table 2). Both products support the same SUM, MAX, MIN, AVG, and COUNT functions on columns and the same scalar functions (those that operate on a single value), LENGTH and SUBSTR (substring). DB2 has extra functions for

TABLE 2: *Comparing Database Manager and DB2 SQL*

SQL COMMANDS	DATABASE MANAGER	DB2
ALTER INDEX	○	●
ALTER TABLE	●	●
BEGIN DECLARE SECTION	●	●
CLOSE	●	●
COMMENT ON	●	●
COMMIT	●	●
CREATE DATABASE	○	●
CREATE INDEX	●	●
CREATE SYNONYM	○	●
CREATE TABLE	●	●
CREATE VIEW	●	●
DECLARE CURSOR	●	●
DECLARE STATEMENT	○	●
DECLARE TABLE	●	●
DELETE	●	●
DESCRIBE	●	●
DROP	●	●
END DECLARE SECTION	●	●
EXECUTE	●	●
EXECUTE IMMEDIATE	●	●
EXPLAIN	○	●
FETCH	●	●
GRANT/REVOKE	○	●
INCLUDE	●	●
INSERT	●	●
LABEL ON	○	●
LOCK TABLE	●	●
OPEN	●	●
PREPARE	●	●
ROLLBACK	●	●
SELECT INTO	●	●
SELECT UNION SELECT	○	●
UPDATE	●	●
WHENEVER	●	●

● = *Yes* ○ = *No*

Database Manager supports most SQL commands in DB2. Omissions include GRANT/REVOKE, which issue and remove user privileges, and EXPLAIN, which gives information on the path that the Data Services engine uses to retrieve data. DB2 has extra functions for manipulating date, time, and representations of data.

manipulating date, time, and representations of data, such as converting a number to a character string. Both products allow *expressions* (values resulting from arithmetic operations on other values) in the SELECT statement. For example,

```
SELECT 1.0 * (max (wt) -min(wt))/
  avg (wt)
FROM PART
```

includes an expression based on three functions of the *wt* column. (To get a decimal answer, multiplying by 1.0 is necessary because *wt* is an integer.)

Both Database Manager and DB2 allow the same formation of *predicates*, collections of conditions on a row or group of rows. Both support standard comparisons (=, >,<,< >, between) and list comparisons (IN, ANY, ALL, SOME), and EXISTS. To create complex conditions and compare one value with another returned from a SELECT statement, developers can combine these comparative conditions with AND, OR, and NOT.

Numerous enhancements to SELECT available on competitive systems, such as Oracle Corporation's ORACLE and SQL Server, could extend Database Manager SQL as well as DB2. Particularly useful would be the ability to nest column functions such as MAX-(SUM(. . .)) and an outer join to retain information about customers with no orders when the Customer table is joined to the invoice table.

Like DB2 and other competitive products, Database Manager provides powerful SQL constructs for inserting data into a database or updating existing data. The following command increases prices under $20 by 15 percent:

```
UPDATE part
SET price = 1.15 * price
WHERE price < 20
```

Database Manager allows inserting data a row at a time or copying them from one or more tables to another table.

To eliminate the need to calculate invoice totals, a developer can create a table called Newtable that contains customer number (**cnum**), name (**cname**), invoice number (**inum**), order date (**odate**), and total amount. The SQL command for inserting data into this table is:

```
INSERT INTO newtable
SELECT cname, inv.inum, count(*),
  sum(price * litem.qty)
FROM customer, inv, part, litem
WHERE customer.cnum = inv.cnum
AND inv.inum = litem.inum
AND litem.pnum = part.pnum
GROUP BY customer.cnum, inv.inum
```

Although this solution saves calculation time, it risks losing consistency with original data because it duplicates columns. To avoid such problems, SQL supports *views*, virtual tables used to assemble specific groups of data. For example, developers can create a view instead of a new table to calculate invoice totals. The SQL command to create such a view is:

```
CREATE VIEW invsum (name, inum, count,
  amount) AS
SELECT cname, inv.inum, count(*),
  sum(price * litem.qty)
FROM customer, inv, part, litem
WHERE customer.cnum = inv.cnum
AND inv.inum = litem.inum
AND litem.pnum = part.pnum
GROUP BY customer.cnum, inv.inum
```

In addition, Database Manager supports both nested selects and correlated subqueries in which the inner SELECT statement uses a value from the outer SELECT statement. To retrieve data from the view, a user issues this command:

```
SELECT * FROM invsum
```

Database Manager updates only those views that are row and column subsets of a table. Views such as **invsum** cannot be updated because Database Manager has no method for determining the repercussions of an update on underlying tables. A SELECT statement can use a view even though Database Manager does not support an equivalent SELECT statement without the view. For example, although Database Manager and DB2 do not nest the column functions, MAX, MIN, SUM, AVG, and COUNT, Database Manager processes the following statement:

```
SELECT max(amount) FROM invsum
```

Database Manager defines views in the same way as DB2, including the CHECK OPTION, which prohibits updating a view with data not part of the view. The limitations on updating views are the same as in DB2: all data are from one table; DISTINCT and column functions (such as MAX and SUM) and GROUP BY and HAVING clauses cannot be present; no subquery (a select statement that is a component of another SQL verb such as SELECT, UPDATE, INSERT, or DELETE) can reference the same table as in the main query.

Database Manager's system catalog is a subset of DB2's; it uses the same table names, but has only 9 tables while DB2 has 30.

Splitting differences. The following SQL commands present in DB2's SQL are absent in the current Database Manager implementation:

- ALTER INDEX, to change the description of an index.
- CREATE DATABASE, to define a database.
- EXPLAIN, to obtain information on how an SQL statement will execute.
- GRANT/REVOKE, to grant or revoke user privileges to an object, such as a database, plan, system, or table.
- PRIMARY key and FOREIGN key in the CREATE TABLE command, to designate primary and foreign keys.
- CREATE SYNONYM, for a table name—for example, a shorter name or unique names for different groups.
- GRANT/REVOKE security.
- EXPLAIN, to produce information on the database access plan, which the user can use to tune SQL statements for improved efficiency.
- LABEL ON, to define labels for default reports.
- UNION, to combine results of two SELECT statements. (However, neither DB2 nor Database Manager support INTERSECTION, which returns rows in the results of both SELECTs, or DIFFERENCE, which returns rows in the results of one SELECT, but not the other.)

Even with SQL commands that both Database Manager and DB2 support, implementation is sometimes different because DB2 supports more features. In the major data-manipulation commands SELECT, UPDATE, DELETE, and INSERT, no significant syntax differences exist; semantic differences occur, however, because Database Manager does not support referential integrity and DB2 does. Although the syntax of DB2 SELECT and Database Manager SELECT are the same, the collating sequence for the ORDER BY clause is governed by EBCDIC sequence on mainframes and ASCII on PCs. Consequently, the same Database Manager and DB2 SELECT, even with an ORDER BY clause, could produce different results. These differences do not impair Database Manager SQL seriously, although they cause additional work for the application developer.

DATA AS *XXX* OBJECTS

Database Manager defines each database in a separate directory called SQL00*xxx*, where *xxx* is a Database Manager-assigned sequential number. To create a database, a developer uses Query Manager or embeds SQL in a program. Query Manager uses an object-oriented approach; objects include databases, tables, and reports. To define a new object, the developer selects New and opens it by pressing F6 or selecting the Open option from the Actions pull-down menu. Query Manager presents a pop-up menu that prompts for database name, path, and password. An empty database initially takes up 500KB.

Each database includes a *system catalog* containing nine data dictionary tables. The catalog (see table 3) describes all objects in the database, including tables, columns, indexes, views, and access plans (methods Data Services uses to access data).

Database Manager's system catalog is a subset of DB2's catalog, using the same table names, such as SYSTABLES, SYSCOLUMNS, and SYSINDEXES. However, it has only 9 tables while DB2 has 30, which address either those features not present in Database Manager—such as SYSTABAUTH and SYSCOLAUTH (to record user privileges on tables and columns), SYSSYNONYMS (to record alternate names for tables

TABLE 3: *Database Manager's System Catalog*

TABLE NAME	ROWS PER OBJECT	INFORMATION STORED
SYSTABLES	One	Table or view name, creator, timestamp, internal description of table, number of columns, file and table IDs, number of pages for rows of data, total number of pages in file, total number of overflow pages
SYSCOLUMNS	One	Column and table names, creator, data type, length and scale, null allowed, data codes for system use, number of values in column, second highest and lowest values, average column length
SYSINDEXES	One	Index and table names, creator, number of columns and column names, internal index ID, uniqueness code, degree of data clustering, number of pages, index levels, distinct first and full key values
SYSVIEWS	One or more	View name, creator, row sequence number, check option, text
SYSVIEWDEP	One	Name of table or view the view is dependent on, creator, object code, view name and creator
SYSPLAN	One or more	Access plan name, creator, binder ID, validity code, time of last bind, number of sections in plan, date and time format, internal information on cursors and host variables
SYSPLANDEP	One	Name of object that plan is dependent on, creator, object type code, plan name and creator
SYSSECTION	One or more	Access plan name, creator, sequence number of row, plan section number, section of plan
SYSSTMT	One or more	Access plan name, creator, sequence number of row, SQL statement number, number of plan section containing SQL, text of SQL statement

Like all SQL-based relational data managers, Database Manager uses a system catalog to store information about each object in a database including tables, columns, SQL statements, and access plans. Most information, such as the creator of the object, time stamp, internal file ID, number of pages in a file, number of overflow records, number of index levels, and format of an access plan, are used by the system to manage the database; however, users can query these tables.

and views), and SYSFOREIGNKEYS (to record foreign keys)—or mainframe features, such as SYSSTOGROUP or SYSVOLUMES, (to reflect operating system differences in data storage).

Because the relational model is based on a three-schema architecture consisting of the internal schema (actual physical storage and location of data on disk), conceptual schema (definition of database tables), and external schema (application's view of the database), transferring an application from Database Manager to DB2 does not require modifying the application except to address additional features. For example, Database Manager programs must edit input data to perform referential integrity checks done automatically in DB2. Operating system differences reflected in the physical design of the database could require changes to the Data Definition Language (DDL), especially to exploit DB2-only features such as primary keys, referential integrity, and storage requirements.

Developers can access catalog information via SQL commands, but the same information is accessed more easily in Query Manager by opening the database table and developing a prompted query or by direct SQL query of the table. One limitation is that Query Manager reports the definition of only one table at a time, not the entire database; developers must run reports separately for every table. This can be burdensome for a large database containing many tables.

Database Manager stores each user-defined table and its indexes in separate files. It stores data in a table in 4,000-byte pages (physical records) and assigns file names. It uses two methods of physical access—sequential and B-tree indexes—and does not limit the number of columns designated as table indexes, each consisting of up to 16 columns, totaling 255 bytes.

Database Manager's optimizer, part of Database Services, is code that determines the most efficient method to retrieve data from a table by automatically using existing indexes. A reorganization utility, REORG TABLE, keeps data in the same sequential order in the table as in an index to improve performance on sequential reports.

Unlike in DB2, the Database Manager developer cannot control an index's physical structure. This has no implications for upward portability of data-manipulation code because, in the relational model, the application is isolated from the physical storage mechanism. However, lack of developer control over physical index structure limits opportunities for performance tuning. For example, DB2 allows the user to specify in which physical file or buffer pool an index goes. Database Manager and DB2 limitations on a database are summarized in table 4.

Database Manager data types are a rich subset of DB2 types. The product supports character strings, numbers, and date-and-time data types. It lacks only graphic character strings of fixed and variable length (GRAPHIC and VAR GRAPHIC), which support double-byte character sets for foreign languages.

Character strings. Database Manager accommodates fixed-length strings to 254 characters and variable-length strings (called VARCHAR) to 4,000 bytes. Database Manager stores longer variable-length strings, to 32,700 bytes, in a file separate from the data record in that table. This limits the way developers can use LONG VARCHAR—they can only retrieve and print LONG VARCHAR columns; but cannot, for example, use them in a WHERE clause of a SELECT to select a row.

Character fields contain ASCII characters unless they are defined for bit data. A developer can store a graphic image in a LONG VARCHAR column, then retrieve the column into a program to reproduce the image.

Numbers. Database Manager stores small integers (−32,768 to +32,767), large integers (−2,147,483,647 to +2,147,483,648), floating-point numbers (2.225E−307 to 1.79769E+308, 64-bit storage), and decimals (maximum 31 digits). These are the same as DB2 except DB2 decimal numbers can be only 15 digits and floating-point numbers are between 5.4E−79 to 7.2E+75.

Database Manager has no money data types, so decimals must be substituted. This could result in round-off error, but the 31 digits of decimal precision in Database Manager are adequate for most applications.

Date/time. Database Manager supports Date, Time, and Timestamp. Unlike

DB2, it does not perform date or time arithmetic. In DB2, the SQL command to find elapsed time between delivery and order dates in the order-entry database is:

```
SELECT inum, ddate – odate
FROM inv
```

Because this SQL statement is not legal in Database Manager, a developer must write an application program and routines to perform date arithmetic. To ensure that Database Manager's SQL complies with SAA, IBM plans to add date-time arithmetic, but has not announced when this will happen.

INTERFACE WITH SHORTCOMINGS

Query Manager is a menu-based interface to Data Services. Developers can use utilities, and create and define databases interactively in Query Manager more easily than from host-language programs using SQL. Through Query Manager, developers and users can run utilities, define databases, retrieve and update data, define reports (forms), paint screens (panels), specify procedures, and define menus.

In a short demonstration program, Query Manager performs well; in continuous use, however, its shortcomings are clear. The screen is divided into an action bar at the top (to access pull-down menus) and a data area (to list objects). Users make selections from menus with cursor keys or a mouse and move to the action bar by pressing F10 or using the mouse. Selecting an option from the action bar produces a pull-down menu with more options. Users choose an item by typing a highlighted letter (for example, *A* for "add a column"), a number that appears beside the selection, a function-key shortcut (called a *fast-key path*) listed to the right of the selection, or the mouse. A small square to the left of the selection identifies choices allowed in the specific context—for example, adding a column to an existing table may be permissible, but changing a column may not. An illegal choice results in the error message, "A field in this group must be selected."

The Databases menu lists all databases previously defined and the object New for creating new ones. After a database name is highlighted, pressing the space bar and hitting F6 or selecting Open from the Actions pull-down menu opens the database. A Main Selection menu then presents seven options: Tables and Views, Queries, Forms, Panels, Procedures, Menus, and Profiles (see photo 1).

TABLE 4: *Database Manager Limitations on a Database*

	DATABASE MANAGER	DB2
Data names (number of characters)	8	8
Columns per table or view	255	300
Maximum table names in SELECT	15[a]	15[a]
Longest SQL statement (bytes)	32,765	32,765
Maximum columns in an index	18	16
Longest index key (bytes)	255	255
Indexes per table	Storage limit	Storage limit
Rows per table	Storage limit	Storage limit
Tables per database	9,999	—[b]
Databases	721	—[b]

[a] *Fewer may be allowed in complex query.* [b] *Depends on available disk space.*

Database Manager can store 721 databases of 9,999 tables each; the space available on the hard-disk drive will limit the number of rows per table. Limits are comparable to those in DB2 except for the number of columns per table or view—DB2 supports 300; Database Manager supports only 255.

Tables and Views lists all tables and views in the database. Operations include defining a new table or view, adding or modifying data, and adding or deleting indexes. For defining, Query Manager menus prompt for type (table or view) and present a form for entry of column names, data types, length, and attributes such as null or non-null values for data. Before exiting the data-definition menu, developers save the definition and Database Manager creates the table or view.

Once Database Manager saves a table definition, developers can add a new column but cannot change or delete existing columns even if data have not yet been entered. They can build or drop indexes as part of the definition. To define a new table based on a previously defined table, developers can retrieve the previous definition, called the *template*, and modify it.

Selecting Add from the Actions menu displays a template with column names that developers fill in. Selecting Change displays a template for specifying search conditions for rows to modify or delete. This is done by filling in simple conditions on columns or by invoking a stored query for more complex conditions. Entries in the Actions menu change after a search. Because no browsing function exists, developers must define a query or use the Change option to browse a table.

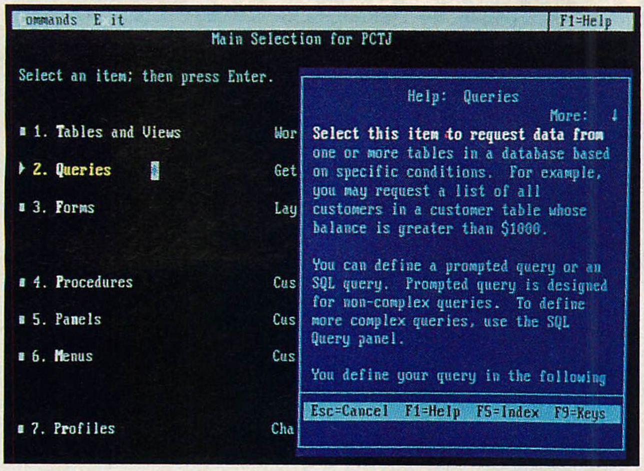
Queries, a prompted interface for querying the database, first prompts for table names. Pressing F4 lists objects, such as tables, columns, or stored SQL statements. Selecting more than one table causes Query Manager to prompt for join conditions, which developers specify by picking join columns from a list. Database Manager does not support joining columns of different data types. Because it also does not support domains, Database Manager has no protection from joining tables based on nonsensical conditions (such as customer to invoices where the customer number equals the invoice number). Selecting Specify produces a menu with options to select columns, row conditions, sort, and duplicate values (see photo 2). Row conditions can include expressions (for example, PRICE * QTY), summaries (for example, SUM (PRICE)), and comparison operators (such as >,<, and =).

Developers can execute a prompted query immediately, save it to run later, or convert it to Database Manager's SQL. The command on the Actions pull-down menu, CONVERT TO SQL, converts the query to SQL syntax while RUN executes the query. Developers cannot edit SQL as a prompted query whether they entered it directly or converted it from a prompted query.

Prompted queries offer only a subset of SQL functionality; for example, they do not support subselects and complex Boolean conditions with nested parentheses. Developers can enter SQL directly and can save SQL statements with variables in them so that they prompt the user for a value.

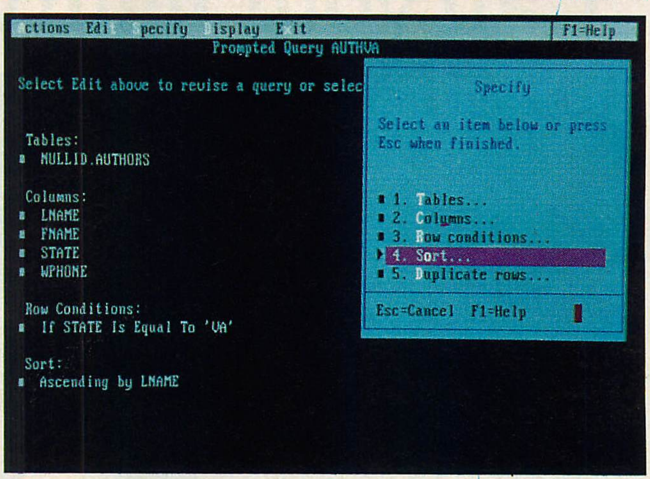
Running a prompted query (developed using Query Manager prompt mode), SQL query (entered using Query Manager's SQL editor), or saved query (statements saved for reuse) produces a default report with a columnar format. Column headings can be column names (such as **cnum**, **pnum**, or **inum**) or the word EXPRESSION followed by the expression's column

PHOTO 1: ***The User Interface***



Query Manager is IBM's menu-driven interface to Database Manager's Database Services engine. The Main Selection menu provides seven options, including access to tables and views, queries, and indexes. Developers can create databases, tables, and queries using Query Manager's prompting mechanism or by directly entering SQL statements.

PHOTO 2: ***Prompted Queries***



Prompted queries are easy to generate, and they insulate users from SQL. Selecting table, columns, row conditions, and Sort cause Query Manager to display additional menus for building a query. Developers can direct Query Manager to generate SQL from the prompted query. Both developers and end users can save and edit all query formats.

number. The format is the default format for the data type; for numbers, the default does not print commas.

Developers format a report by selecting Forms either from a query or from the Main Selection menu. They override defaults by specifying column headings and widths, page spacing, headers and footers, and up to six levels of breaks (a mechanism for grouping data). For example, if a report on a view of the customer table joined with the invoice table sets BREAK1 on **cnum** and BREAK2 on **inum**, the report displays all items ordered by that customer before displaying the next customer. Database Manager performs summary operations for all break levels. It prints to any printer OS/2 supports, but not to PostScript printers.

In formatting a report, developers can switch from form definition, to the query that generates data, to the report. They can save and reuse the report format with other queries if the data generated match data the form accepts. Reports more complex than simple columns require writing a program.

The Panels option defines screens for adding or changing data, but not for browsing. Developers cannot alter the layout of a default panel created for a table or view. They can define panels based on multiple tables, but can use only one level of hierarchy between a root table and one of its subtables.

Consider a panel that shows a customer's number, name and address, and information for an order, including order number, date, part, and quantity. To retrieve information for an invoice and then scroll subsequent invoices with corresponding line items requires two levels of hierarchy (customer to invoice and invoice to line item) and so cannot be performed in Query Manager. A panel definition can include a mix of text, data from columns, and computed values. Developers can specify operations to be performed in the Actions menu in the panel's action bar.

The panel option introduces a *connection type*, specifying the relationship between a root table and subtable as one-to-one, one-to-many, many-to-one, or many-to-many. Depending on the relationship, an action (such as DELETE) can produce a different result.

The Procedures option provides a procedural programming language, including assignment, conditional, and looping statements, for executing Query Manager statements to run a panel or print a report. These commands must be enclosed in single quotes. For example, a procedure to run a panel for adding data and running a report is:

```
'begin work'
'run panel customer (mode = add)'
if rc = 0 then
   'run query custlist'
   'print report (form = custform)'
   'end work'
else
   'cancel work'
end
```

A TRACE statement for debugging procedures creates a file listing each procedure line executed, as well as the results of expressions. A developer can follow each step in executing a query to uncover a suspected error.

Query Manager's editor for changing SQL statements is primitive. It allows entering text only on the line where the cursor is placed, inserting a new line, and deleting characters and lines. Lines cannot be split in two, wrapped at the end, searched and replaced, nor blocks moved or deleted. This is bothersome when entering long procedures. Finally, Database Manager does not support any third-party text editor such as WordPerfect Corporation's WordPerfect.

After defining panels and procedures, developers can structure them into a customized application using Menus from the Main Selection screen. This creates a list of choices in the data area of the screen. Each menu operation is associated with a Query Manager command, such as RUN PROC. A menu selection can invoke other menu options, building a complete menu tree to form the backbone of an application. Finally, selecting Profiles allows users to change default settings, such as those for user sign-on, printers, and import/export.

The limitations of Query Manager's Procedures and Panels and the inelegance of Menus may lead developers either to use host-language programs or wait for third-party interfaces. IBM is actively encouraging vendors, including DataEase International (DataEase) and Borland International (Para-

dox), to port their own interfaces to work with Database Manager.

For developing C programs, Query Manager allows developers to use SQL directly against the database for both data definition and data manipulation. This allows checking and storing the SQL embedded in programs.

Query Manager has shortcomings. Its character-based interface (which remains in release 1.1) makes mouse movement jerky because the mouse moves from one character to the next (80-by-25) instead of from one pixel to the next (640-by-480 on a VGA screen).

Numerous inconsistencies within Query Manager exist as well. When using the cursor and function keys instead of a mouse, the developer cannot access the action bar with the cursor keys but must press F10. If a selected menu option does not have the function desired, hitting the Esc key returns the cursor to the data area, forcing the user to press F10 again to return the cursor to the action bar.

In addition, Query Manager does not support Shift-click, the common mouse notation for selecting multiple objects in which users click the mouse on multiple objects while holding the Shift key down. Instead, selecting multiple Database Manager objects requires doing an operation multiple times.

Another inconvenience is trying to exit the menu hierarchy. No exit exists to the first level so users must pass through each menu level on their way out. Function keys exit and save or exit Query Manager; to exit one level without saving requires a menu selection. IBM plans to add a function-key assignment for exit without saving.

Finally, Query Manager documentation contains neither a menu map nor a list of function-key equivalents, so users must make one or trust trial and error. A help key explains a menu selection or produces a multiscreen list of function-key equivalents.

LANGUAGES HOSTING SQL

Complex applications require accessing and manipulating data via a host-language program. Host-language access to Database Manager is identical to that in DB2, including error codes.

Database Services provides an application programming interface (API) to Database Manager. Its five parts are:

- A precompiler for converting embedded SQL to code acceptable to the host-language compiler and for producing access paths or a bind file.
- A binder designed for tying SQL to a specific database.
- Environment routines that provide functions for creating and deleting a database, connecting to a database, recovery, and so on.
- Utilities for the import/export of data, the backup/restore of a database, and so on.
- Configuration routines for altering system and database configuration values, such as number of buffers.

The programming interface to Data Services is through SQL statements and function calls embedded in the application. Database Manager supports two types of embedded SQL: *static* (queries not changed during execution of a program) and *dynamic* (queries generated during execution). Developers use static SQL when they know the SQL statement to execute (such as SELECT or INSERT).

Using transactions to coordinate processes, Database Manager prevents multiple processes from causing inconsistencies in a database.

For static SQL, Database Manager, like DB2, has a precompiler to translate EXEC SQL statements into calls and bind the program, which produces an access plan. The host-language compiler then compiles the modified source to object code and Database Manager links all object module libraries into executable code. During execution, SQL calls invoke the access plan to guide Data Services to data.

The access plan differs with data in the database. Running the application against different databases, as most third-party software vendors would, requires generating a new access plan from the precompiler for each database and could require third-party vendors to ship applications with source code. However, Database Manager has an option for deferred bind, which is not available in DB2. This is done by calling SQLBIND with the /N option. The precompiler produces a *bind file* containing SQL source code and information to generate an access plan. The bind function binds the application to a specific database.

Should the access plan no longer apply to a database because, for example, an index is dropped, then Data Services automatically rebinds. For drastic changes to the data structure, such as a missing column or table, Database Manager returns an error code to the application. Invalidating an access plan occurs only if changes occur to the database in use. For example, deleting a column from the Part table or dropping an index on the table does not affect programs not using that column or index.

If an interactive program must construct SQL statements based on user input, developers need dynamic SQL. Database Manager handles dynamic SQL the same way as DB2. The host-language program places executable SQL in a host variable, checks syntax with the PREPARE statement, and executes with the EXECUTE statement. Communications between Database Manager and the host variables use the SQLDA, a variable-size data structure to pass data between an application and Database Services. Because Database Manager does no precompiling and binding ahead of time, the system must parse, validate, and optimize access to SQL. This makes dynamic SQL slower and more complex than static SQL.

Because SQL returns tables, but host languages expect records, the cursor picks records from the table one at a time. The program issues DECLARE, to define a cursor for the SQL statement; OPEN, to open the cursor and initiate execution of the SQL; FETCH, to retrieve one row at a time from the result table and move the data into host-language variables; and CLOSE, to inactivate the cursor (see figure 2).

TRANSACTION CONCURRENCY

To prevent multiple processes—and multiple users when Database Manager becomes multiuser—from causing inconsistencies when they update a database simultaneously, Database Manager coordinates processes using transactions (units of work). Each transaction is a collection of actions on the database that must complete before the database changes. An SQL command starts a transaction and a COMMIT or ROLLBACK ends it (a COMMIT makes permanent all database changes and a ROLLBACK undoes all changes). In an accounting transaction, ROLLBACK can back out all changes to accounts where the sum of debits does not equal the sum of credits.

Simultaneous multiple transactions must not interfere with each other and destroy database integrity. Database Manager uses *locking* to prevent access to data changed by another program

FIGURE 2: *Embedded SQL*

```
EXEC SQL DECLARE x CURSOR FOR  /* Declare a cursor x     */
SELECT cnum, cname, city       /* to point to  the rows */
FROM customer                  /* of the SELECT          */
WHERE STATE = 'MD'             /* statement              */


EXEC SQL OPEN x                /* Open the cursor and   */
                               /* perform the select    */


EXEC SQL FETCH x into : num, :name, :city /*Fetch the first row*/
                                          /*into host variables*/
                                          /*num, name, and city*/


while (sqlca.sqlcode == 0) {
   do interesting things
   EXEC SQL FETCH x                       /* Fetch next row    */
   into : num, :name, :city
}
EXEC SQL CLOSE x                          /* Close the cursor  */
```

Because SQL is only a data sublanguage, it is frequently embedded into a host-language program that can process only one row of data at a time. The SELECT verb can return a table of results, so Database Manager supports cursors so that the user can step through each row.

FIGURE 3: *Database Views*

```
create view level1 (a#, aname, s#, sname, qty) as
      select  assy.p#, assy.pname,
              sub.p#, sub.pname, qty
   from part assy, link, part sub
   where assy.p# = link.a#
       and sub.p# = link.s#

create view level2 (a#, aname, s#, sname, qty) as
   select       assy.a#, assy.aname,
                sub.p#, sub.pname,
                assy.qty * link.qty
  from l1 assy, link, part sub   where assy.s# = link.a# and
sub.p# = link.s#

create view level3 (a#, aname, s#, sname, qty) as
   select       assy.a#, assy.aname,
                sub.p#, sub.pname,
                assy.qty * link.qty
  from l2 assy, link, part sub
  where assy.s# = link.a# and sub.p# = link.s#
```

Views are virtual tables created by selecting specific columns from one table or joining several tables. Views in the bill-of-materials database, created by joining seven tables, are used in queries to test Database Manager's speed in retrieving data from multitable views (see table 5).

but not yet committed. Database Manager locks rows and tables.

A lock by one program prevents data access by another. For maximum concurrent use of data, a row-level lock should be used instead of a table-level lock. However, because too many locks can result in a system spending all of its time managing them, Data Services automatically converts numerous row locks into a single table lock. The amount of storage for lock lists in the database configuration—8 4KB pages is the default, 250 4KB pages is the maximum—determines when the system performs such a conversion.

Database Manager applies one of several share and exclusive locks, depending on whether the user is reading, reading with intent to update, or updating. These include:

- Intent Share (IS), the lock owner has read-only access to the object but all others can read and update.
- Share (S), the lock owner and all others have read-only privileges.
- Exclusive (X), only the owner can access the object for read or update.
- Intent Exclusive (IX), all applications can read and update; the owner acquires an S lock on all rows it reads and an X on all rows it updates.
- Share with Intent Exclusive (SIX), the owner has an X lock on rows it updates, but all others can read unlocked rows.

During system reading and updating, Database Manager automatically locks a row or table until the developer issues a COMMIT or ROLLBACK command. Although this approach, called *repeatable read*, provides a high degree of consistency, it lowers concurrency (simultaneous access) by allowing readers to block updaters. An operation that requires scanning a table, such as a SELECT based on a nonindexed column, results in a table-level lock because all rows must stay locked until the transaction ends. This is not a serious problem until Database Manager becomes multiuser and lack of concurrency causes long user waits.

Developers can override default locks with the Lock Table command. With Share mode, the application gets a snapshot of a highly active table; with Exclusive mode, the application can lock out others during an update of a large portion of a table. In addition to controlling lock types, developers can control lock duration.

Locking levels in Database Manager allows for more concurrent operation than in DB2, where locks can be at the level of the page (physical collection of rows) or table space (physical file that can contain one or more tables). During testing, running two Query Manager sessions simultaneously—a long SQL SELECT and a data READ from one of the tables—produced no concurrency problems. An attempt to update data, however, met with a "Please wait" message. When the query completed, the update did not start; the user must issue an explicit COMMIT to release the lock. Database Manager should have an automatic option that frees locks at the end of a transaction. This is particularly important because readers can block updaters for a long time.

DB2 provides a concurrency mechanism above Database Manager called *cursor stability*. Other users cannot change updates, but a record read could change even while users are looking at it. IBM should add cursor stability to Database Manager.

Data Services also detects deadlocks. The frequency of checking for deadlock is a parameter in the database configuration. The default is every 10 seconds; the range is between 1 and 600. Although checking too often slows the system, checking infrequently can hang up a transaction.

Database Manager writes all database changes to a log file and automatically uses the information to recover the database should a transaction roll back, the program terminate abnormally, or the system go down. The size of this log ranges from 12 to 999 4KB pages, with a default of 50 pages, and is specified in the database configuration. Database Manager resets the log when the database is not being updated—this is called a *hard checkpoint*. With many applications, enough log activity can occur to fill the log before a hard checkpoint is performed, producing an error message.

Automatic recovery returns the database to a state where every transaction committed appears in the database and all changes due to uncommitted data (called *dirty data*) roll out. This can be done because the log file con-

tains both before-change and after-change images of the database. However, Database Manager does not report to the user or database administrator any transactions that do not complete. Unless developers write applications to identify that transactions are committed, the user or database administrator must manually determine which transactions have to be redone. This system of logging and automatic recovery is similar to the DB2 approach. Both could benefit by being more informative to users.

Database Manager provides several controls for tuning database performance. Developers adjust these by changing defaults in the database configuration. A developer can increase (to reduce I/O) or decrease (to save memory) a least-recently-used (LRU) buffer pool that is by default 16 4KB pages. Similarly, developers can change the number of files open per application from the default value of 20. The more files open, the lower the overhead of opening and closing files, but the more memory consumed. Developers also can control recovery-log size and frequency of checkpoints.

Database Manager has no performance monitoring program to help tune the database, so setting these values is done by developer trial and error. IBM and independent vendors supply tuning facilities (such as Explain) for DB2 and are likely to make them available to Database Manager in a future undetermined release.

THE SCOOP ON UTILITIES

Database Services utilities import and export data, back up and restore the database, reorganize files, and compile database statistics. These utilities are accessed from Query Manager or through host-language programming. In most cases, developers will want to use these utilities from Query Manager, where the menu interface makes them easy to use and they require less effort than running programs.

Database Manager imports and exports data to and from delimited ASCII files, Lotus 1-2-3 and Symphony files, and IBM's IXF format to exchange data with DB2. Developers specify the desired Lotus format or ASCII delimiters as part of a profile used with different databases. Date data can be imported in only one format (*mm-dd-yyyy*), which could cause developers to spend some time transforming existing data. The IXF format stores the table and index definitions when exporting data; when importing, it defines the table and builds indexes. The other formats require developers to define tables and build indexes.

The import/export utility works quickly and well from Query Manager. When it loads or unloads data, Database Manager stores error messages in a separate file. A screen message indicates only that error messages exist. Query Manager should report the number of rows successfully processed and the number rejected. On import, it should set up a file of rejected records, so developers can edit them and rerun the import against the failed records.

Database Manager security, which prompts for a password when a database is created, is much lighter than typical SQL security.

Database Manager's backup/restore utility, called SQLUBACK, works well. When a disk fills up, the system prompts for the next disk. It backs up the entire database or just the changes, depending on which backup code the developer gives (0 for entire and 1 for changes only). Backing up a 1.6MB collection of files in the order-entry database took only 1.5 minutes.

Frequently, updated tables can become fragmented and thus increase the number of I/Os to retrieve data. However, reorganization in Database Manager removes fragmentation by allowing developers to store data in sequential order based on one of the indexes. This is different from DB2, in which defining an index as "clustered" informs DB2 that it should keep the database in sequential order.

Data Services keeps statistics on physical storage of data and indexes, such as a special join algorithm that Database Manager chooses because of the presence of indexes. For best performance after data change significantly, developers should update these statistics so that the Database Manager's internal optimizer can choose a good access path. Query Manager does not let developers update statistics for the entire database, but only a table at a time. This is tedious for 10 or more tables. It would be better for Query Manager to support both database and table levels.

SPARSE SECURITY FEATURES

Password protection is the Database Manager security mechanism for databases. Database Manager prompts developers to specify a password when they create a database. This limits access to users who know the password.

This is much less than the typical SQL security provided by DB2, which uses GRANT/REVOKE. In DB2, a user can GRANT privileges such as INSERT, SELECT, UPDATE, or DELETE on a table or view to other users, who in turn can grant these privileges to others. Should a privilege be revoked, all dependent privileges are revoked.

The ability to use GRANT with VIEWS provides great flexibility. For example, a view called CHEAP on the PART table can consist only of parts costing less than $20; giving another user access to the view and not the base table ensures the user can order only inexpensive parts. In a multiuser database, this mechanism helps efficiently administer security and should be added by IBM. In a single-user system, it is not as important.

STANDARD MANUALS FALL SHORT

The Database Manager documentation that comes standard with Extended Edition consists of a short booklet, *SQL Concepts*, a 250-page section of the *Extended Edition User's Guide* called "Using Database Manager," and appendixes on designing the database, importing data, and reference syntax for Query Manager commands.

The "Using Database Manager" section is a tutorial and user guide on Query Manager. Working through the examples leaves developers reasonably conversant with Query Manager facilities, but important reference material is missing. For example, no Query Manager menu map exists and, although the system uses function-key equivalents for menu shortcuts, the documentation does not list those equivalents or provide a keyboard template.

Amazingly, no standard reference documentation exists on SQL syntax or using the database engine from a host-language program. Developers need two extra-cost manuals to use Database Manager effectively. The *IBM OS/2 Extended Edition SQL Reference* to syntax and usage, at $25, is excellent. It uses diagrams to show syntax. The *IBM OS/2 Extended Edition Database Manager and Programming Guide and Reference* (also $25) describes using Database Manager from C programs and details Environment and Utility commands, messages, and return codes.

GOOD AT SIMPLE TESTS

To measure performance, Extended Edition, Database Manager, and three test databases were loaded into a PS/2 Model 60 (10-MHz, 80286 with one wait state) with a 40MB hard disk (40-ms access time plus disk caching) and 5MB of memory. A single-table employee database correlated subqueries and self joins. A small bill-of-materials database tested performance using complex views.

Most of the performance tests were executed using the order-entry database with 464 rows in the customer table, 1,202 rows in the invoice table, 7,212 rows in the line-item table, and 498 rows in the part table. Total sequential storage is about 300KB. Data actually required less than the sequential storage, but indexes took up quite a bit of space. For example, in the line-item table, data were 152KB and the index file was 590KB (about 200KB per index). With the additional space required for storing queries, reports, and panels, total storage for the database was 1.6MB.

Loading data took 10 seconds for the customer table and 36 seconds for the invoice table. Building indexes for the customer table took 6 seconds, and building indexes for the line-item table took 1 minute 40 seconds each. SQL statements to define the test database are shown in figure 3.

Three sample SQL statements were run against the order-entry database. To retrieve invoices for a particular customer, the following statement tested retrieval against a single table of 1,202 rows. It executed in one second, both with and without an index on **cnum**.

```
SELECT cnum, inum, odate
FROM inv
WHERE cnum = '457'
```

To find the total number of line items and amount for each order, a second SQL statement tested joining four tables with a group clause.

```
SELECT cname, inv.inum, count(*),
  sum(price * litem.qty)
FROM customer, inv, part, litem
WHERE customer.cnum = inv.cnum
AND inv.inum = litem.inum
AND litem.pnum = part.pnum
GROUP BY customer.cnum, inv.inum
```

It was performed both with and without indexes on columns in the join and the group. The statement executed in 5 minutes 40 seconds with an index and 8 minutes 20 seconds without one.

A final statement finds customers who account for more than 10 percent of total business. This statement requires both a subquery and a condition on a group. The query took 20 minutes to run with indexes; it was not run without indexes:

```
SELECT cname, sum(price * litem.qty)
FROM customer, inv, part, litem
WHERE customer.cnum = inv.cnum
AND inv.inum = litem.inum
AND litem.pnum = part.pnum
GROUP BY customer.cnum
HAVING sum (price * qty) >
```

Increasingly complex requirements resulted in only modest increases to the amount of SQL code. Testing SQL statements ensures that they accomplish what they are intended to do. Sequential performance was impressive, reflecting a good optimizer and good memory use.

The Data Services engine is impressive for a first release, but it is missing important SQL functionality present in DB/2.

PC Tech Journal's data manager benchmarks were run using a 1,202-row table. (For a full explanation of the test database constructed for the benchmarks, see "Evaluating Database Managers as Development Tools," Julie Anderson, August 1985, p. 46.) Tallying the number of sales made by a salesperson (unindexed) took about 12 seconds. Changing the name of one salesperson (78 out of 1,202 rows, no indexes) took 4 seconds. Doing the same operations on **cnum**, an indexed column, took less than 1 second for the tally, and changing the **cnum** on three records also took less than 1 second.

The small bill-of-materials database for a furniture company consists of a part table with 9 entries and a link table with 16 entries. Database Manager created the three views shown in figure 3. The views are complex and include joining views with other views. Because the tables are small and can reside entirely in memory, this test measures the performance of a simple join with seven tables based on views. Database Manager took only seven seconds to perform this test. The performance of the database engine is good for simple, single-user tests.

FUTURE BRIGHT

A new generation of data managers is entering the market. These products are fully relational, use SQL to access data, boast strong database engines with a variety of user interfaces, and are more akin to their mainframe brethren than to early stand-alone PC products. IBM dominates the mainframe relational market with DB2 for MVS and SQL/DS for VM. Can it repeat this success in the PC world with Database Manager?

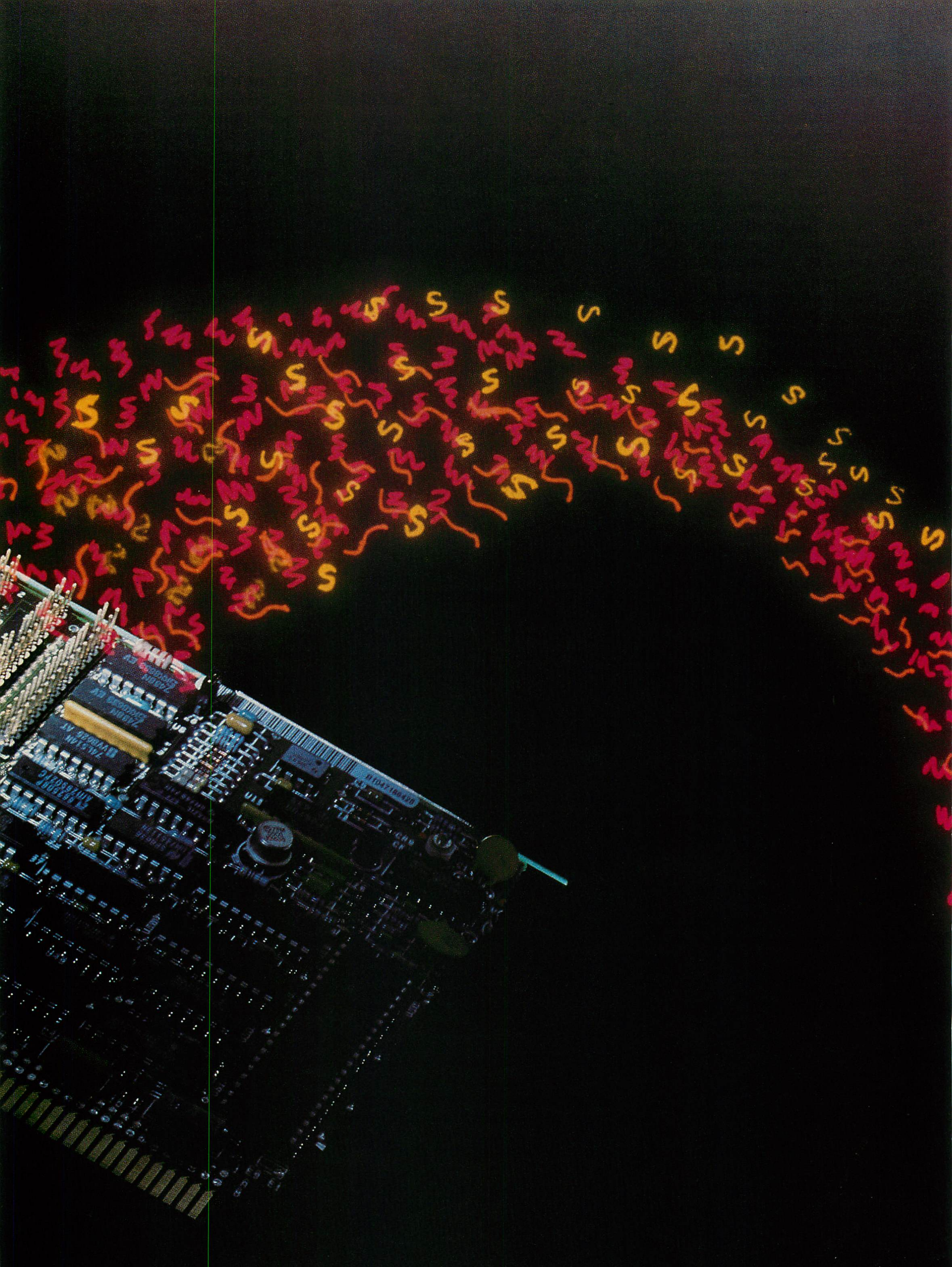
Database Manager's Data Services engine is impressive for a first release. It has a good SQL implementation, respectable performance, general compatibility with DB2 and SQL/DS, an advanced locking and logging feature, and utilities for optimizing the database. On the down side, it is missing some important SQL functionality present in DB2, such as support for primary keys, domains, and referential integrity. What's more, it is only a single-user system and does not function as a network server. These are holes that IBM is sure to plug, but the six-million-dollar question is "When?"

Database Manager's user interface, Query Manager, has shortcomings. It has functionality for building only fairly simple applications. Even in Extended Edition 1.1, Query Manager does not support Presentation Manager and thus retains its character-based interface.

In terms of overall acceptance, Query Manager will probably have little effect; the excellence of the IBM engine will certainly attract many developers to port their own interfaces and application development tools to this engine. Developers familiar with the elegant interfaces of many PC products will be able to select from among ones similar to their favorite PC data manager; those already in IBM shops currently using DB2 and QMF will not be bothered by Query Manager's quirks.

In fact, those in IBM shops will reap the first benefits from Database Manager—they will be able to develop on the PC and port their applications to the mainframe with only minor changes to take advantage of DB2's enhanced features. It is these users who will determine the success of IBM's Database Manager.

Herbert A. Edelstein is a principal of Euclid Associates, a consulting firm specializing in database management and desktop publishing. He is a consultant, speaker, and seminar instructor on SQL, database management systems, distributed processing, and desktop publishing.



Disk Interfaces for the High End

A 25-MHz, 80386-based system without the right peripheral interface is just a fast machine spinning its wheels. Two hard-disk interfaces, ESDI and SCSI, keep pace with today's high-end machines.

PETER G. AITKEN

You can get ahead of yourself more quickly in computing than most any field. No sooner do you upgrade one component in your system—just to keep stride with the industry—when another appears miserably slow by comparison. So it goes.

When the IBM PC/XT was introduced in 1983, its 10MB 100-millisecond hard disk was a marvel of technology, with unheard-of storage capacity and speed. The hard disk connected to the PC's 8-bit bus (which ran at a "blazing" 4.77 MHz) via the popular ST-506 hard-disk interface developed by Al Shugart of Seagate Technologies.

Technology has progressed such that ST-506 no longer keeps pace with high-end systems. Two interface standards have supplanted ST-506: the enhanced small device interface (ESDI) and the small computer systems interface (SCSI). Both are considerably faster, and each has characteristics that recommend it for certain configurations.

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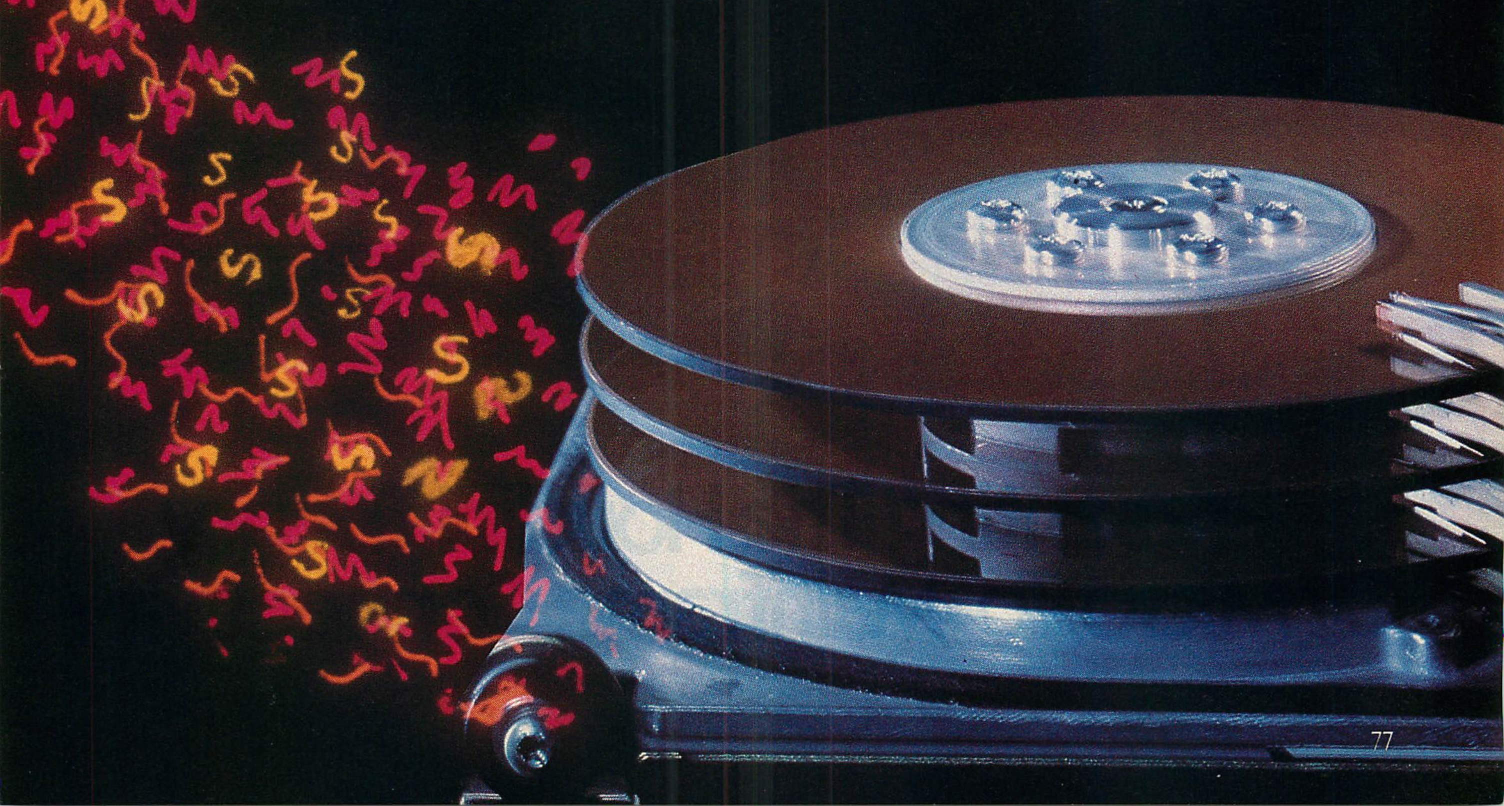


During its tenure, ST-506 was more than adequate for the job. In fact, the ST-506/disk combination transferred data much faster than the computer could process them. This forced hardware designers to reduce the hard disk's data-transfer rate by formatting it with an interleave factor of 6, thereby synchronizing the transfer rate with the host system's processing speed. The effective transfer rate was approximately 85KB per second (KB/s).

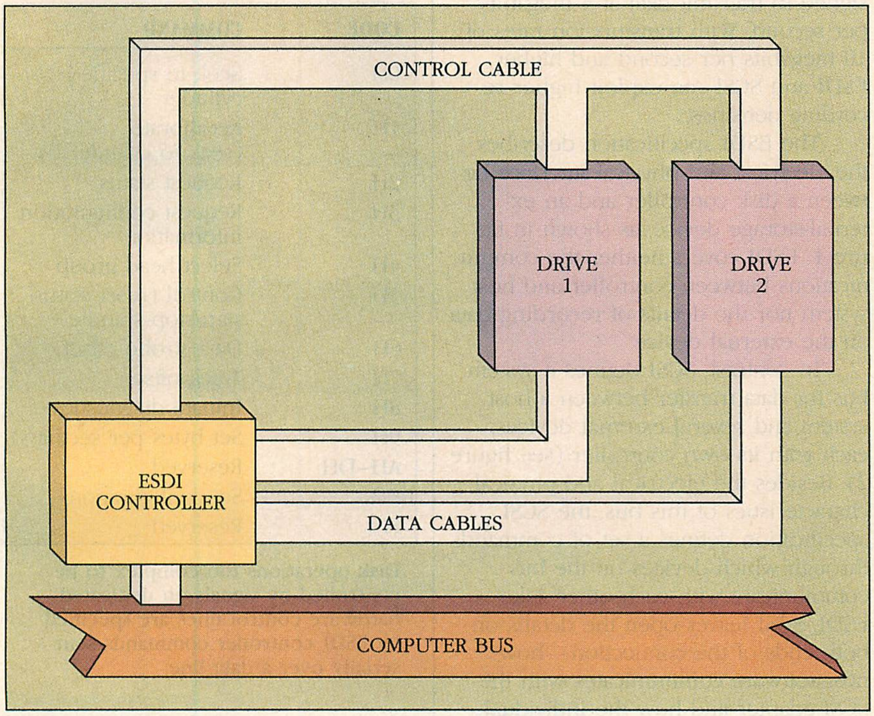
Computer hardware engineers simply have a penchant for making things go faster. They soon produced faster (and larger) hard disks, with typical access times of 40 ms, and faster computers—the PC/AT came out of the gate in 1984 running its 16-bit bus at 6, then 8 MHz. Yet, the ST-506 interface was still up to the task, achieving data-transfer rates of about 165 KB/s in an AT, roughly double that in an XT.

Enter the 80386 in 1986 and, not long after, a rush of 20- and 25-MHz computers, with hard-disk access times in the teens of milliseconds. Now an ST-506 interface creates a serious data flow bottleneck because its maximum data-transfer rate is significantly slower than the throughput capacities of the disk and the computer. Some manufacturers enhance ST-506 performance with faster transfer speeds and run length limited (RLL) data encoding to increase data density on the disk. Nevertheless, inherent ST-506 limitations (primarily its slow transfer rate) make enhancing its performance impossible for today's high-end systems.

Not surprisingly, 1986 also saw the establishment of ESDI and SCSI. Together, they have almost completely displaced ST-506 as the interface of choice for network file servers and other high-performance applications. Most high-end PC systems are available with ESDI controllers as standard equipment, and many vendors offer both ESDI and SCSI hard-disk systems as upgrade units.

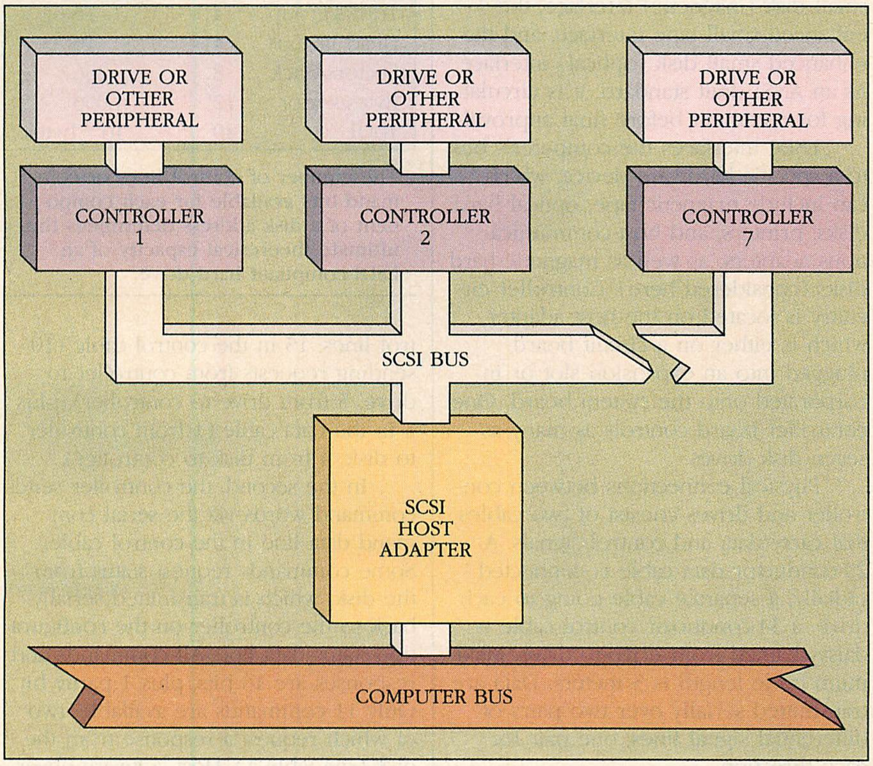
These two interfaces are superior to ST-506 primarily in their high transfer rates—about an order of magnitude faster. The maximum data-transfer rate of a hard-disk system is limited by the rate that data pass the read head, which is a function of two factors: rotation speed and recording density. All 5.25-inch hard disks rotate at 60 revolutions per second. ST-506 disks use 512 bytes per sector and 17 sectors per track. The result is a best-case transfer rate of (60*512*17*8) or 4,177,920 bits per second. Higher rates can be obtained by increasing either the sectors per

FIGURE 1: ***ESDI Architecture***



The enhanced small device interface (ESDI) directly interfaces a computer's bus to one or more hard disks. Circuitry on the host adapter converts disk access commands issued by the host software into hardware-specific control signals.

FIGURE 2: ***SCSI Architecture***



The small computer systems interface (SCSI) defines an external bus that connects a host computer with as many as seven peripheral devices in a daisy-chain configuration. The SCSI host adapter converts operating system commands into SCSI bus commands; each peripheral has its own controller, which, in turn, converts SCSI bus commands into hardware-specific control signals.

track or the sector size. However, ST-506 is further limited because it is designed to transmit data at 5 megabits per second. With transmission rates of 10 megabits per second and higher, ESDI and SCSI can exploit higher recording densities.

The ESDI specification describes the electrical and physical interface between a disk controller and an external-storage device, as shown in figure 1. ESDI covers neither the communications between controller and host system nor the details of recording data on the external device.

In contrast, SCSI defines a system bus for data transfer between a host system and several external devices, each with its own controller (see figure 2). Besides the electrical and physical characteristics of this bus, the SCSI specification defines a set of commands through which devices on the bus communicate with each other. Like ESDI, SCSI leaves open the details on both ends of the connection—how host software communicates with the SCSI adapter and how the individual controllers implement the commands they read from the bus.

CONTROLLING WITH ESDI

The ESDI specification merges three narrower specifications: the enhanced small disk (magnetic) interface, the enhanced small tape interface, and the enhanced small disk (optical) interface. As an ANSI draft standard, it is circulating for comment before final approval.

ESDI interfaces the computer's bus to a specific hardware device, which can include magnetic tape, optical hard disks, printers, and host-communications adapters, as well as magnetic hard disks (considered here). Controller circuitry is located on the host adapter, which is either on a circuit board plugged into an expansion slot or incorporated onto the system board. One controller board controls as many as seven disk drives.

Physical connections between controller and drives consist of two cables that carry data and control signals. A 20-conductor data cable is connected radially, a separate cable going to each drive; a 34-conductor control cable is daisy-chained from drive to drive. Maximum cable length is 3 meters. Data are transmitted serially over two pairs of differential signal lines, one pair for each direction.

The controller exchanges control and status information with the disk in two ways. In the first, the controller activates the appropriate dedicated control lines: 15 in the control cable (10 sending requests from controller to drive, 5 from drive to controller), plus 5 in the data cable (1 from controller to disk, 4 from disk to controller).

In the second, the controller sends command words via the serial command data line in the control cable. Some commands request status from the disk, which is transmitted serially back to the controller on the configuration/status data line. All commands and responses are 16 bits, plus 1 parity bit. Only 11 commands are available, two of which request a response from the disk (see table 1). Host software never directly issues these commands nor sees responses.

Actual data are transmitted serially between controller and drive at the rate of the read/write clock (currently specified as 10 MHz). Assuming an average 10 bits per data byte (allowing for error correction and address data), this produces an effective transfer rate of about 1MB per second (MB/s).

The controller specifies the location of data to be read or written by physical address consisting of cylinder number, head number, and sector number. As shown in table 2, the number of bits and signal lines available to specify the various components of the address allows a maximum theoretical capacity of one terabyte (1TB—that is, 2^{40} bytes, or 1 million megabytes). The limitations of the host system, however, can impose different limits on the device. For example, DOS and OS/2 require a sector size of 512 bytes, cutting the maximum capacity by a factor of eight, to "only" 137GB.

The focus of ESDI is quite narrow. It leaves many details on both sides of the controller-disk interface undefined, most importantly, the software interface between host and controller. Implementors can choose different command structures, so that two ESDI controllers are incompatible at the software level. The device drivers, whether in ROM BIOS or in RAM, must adapt different devices to an operating system.

For example, the host command structure for the ESDI controller in the IBM PS/2 Model 70 (for both 60MB and 120MB disks) specifies disk locations in terms of 32-bit logical sector numbers, rather than cylinder, head, and sector. The host-controller interface can restructure the drive into logical dimensions that differ from the physical ones. More specifically, the 120MB disk on the PS/2 Model 70-121 has 920 cylinders, 8 heads, and 32 sectors per track. DOS, however, reports the disk as having 115 cylinders, 64 heads, and 32 sectors per track. Each logical cylinder, therefore, contains exactly 2^{20} bytes (1MB), making it easier to specify partition sizes in cylinders when partitioning the disk with FDISK.

On the other side of the controller, the ESDI specification does not mandate the actual recording methodology, redundancy for error recovery, or format of sector address marks. Within the controller itself, the standard makes no requirement for buffering or error correction. An original equipment manufacturer (OEM) can provide a design for these aspects of the disk subsystem. Thus, the range of possible implementations of an ESDI disk subsystem is quite broad, with a corresponding spread of performance.

TABLE 1: ***ESDI Commands***

CODE	COMMAND
0H	Seek to specified cylinder
1H	Recalibrate (seek to cylinder 0)
2H	Request status
3H	Request configuration information
4H	Select head group
5H	Control (reset status, start/stop spindle)
6H	Data strobe offset
7H	Track offset
8H	Initiate diagnostics
9H	Set bytes per sector
AH–DH	Reserved
EH	Set configuration
FH	Reserved

Disk operations too complex to be controlled by signals on dedicated hardware control lines are specified by ESDI controller commands sent serially over a data line.

TABLE 2: ***ESDI Capacity***

	NUMBER OF BITS	MAXIMUM COUNT
Cylinders	12	4,096
Tracks/group	4	16
Head groups	4	16
Sectors/track	8	256
Bytes/sector	12	4,096
Total	40	10^{12} bytes

The number of control lines or command bits available for each component of a disk address determines the ultimate theoretical capacity of an ESDI-compliant hard drive.

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SCSI CONNECTIONS

The SCSI specification, defined by ANSI standard X3.131-1986, grew out of the earlier SASI (Shugart Associates System Interface) developed in 1979 to connect 8-inch Winchester disk drives to microcomputers. It since has been enhanced to control tape drives, printers, coprocessors, and optical disks.

SCSI is not a device interface, but rather specifies the physical and electrical characteristics of a bus for interconnecting several peripherals, a set of commands for controlling them, and a protocol for arbitrating contention and controlling communications among them. The bus is a 50-conductor cable that daisy-chains as many as eight devices. The maximum length between devices is 6 meters if the cable is wired with single-ended signal pairs (one wire of each pair grounded) or 25 meters with differential signal pairs (complementary signals on the wires of a pair). The current SCSI standard specifies an 8-bit data width within this bus; the proposed SCSI II specification expands this to 32 bits (see the accompanying sidebar, "SCSI II is Due").

Each device on the bus is an *initiator* that makes requests of other devices (for example, a host computer), a *target* that carries out the request (for example, a disk drive), or both (for example, a coprocessor that responds to the CPU and requests services from disk or memory subsystems). An initiator connects to the bus through a SCSI host adapter, which, like a device controller, is either plugged into an expansion slot or built onto the host system board. Each target device consists of a SCSI peripheral adapter, a device controller, and as many as eight peripherals. One SCSI bus thus connects a single host to as many as 56 peripherals.

Only two devices can communicate over the SCSI bus at one time. An initiator must wait for the bus to be free before taking control; if several initiators request the bus simultaneously, the one with the highest priority gets it (priorities are fixed at installation time). A higher-priority device cannot preempt the bus; the priorities matter only in arbitrating multiple requests when the bus is free. In systems with only one initiator, the host interface can be configured without this arbitration logic.

Once the initiator controls the bus, it establishes communications with a target device by means of hardware handshake lines, then gives the target control. Thereafter, the target controls the transfer of all data on the bus: it requests the commands from the initiator, indicates when it is ready to send or receive data or send status information, and frees the bus at the completion of the command. In a system with bus arbitration enabled, the target can release the bus before the completion of the command (for example, during a disk seek), then request the bus, as if it were an initiator, when the time-consuming operation ends.

The default data-transfer protocol on the SCSI bus is asynchronous, in which the target and initiator exchange a request/acknowledge handshake for each byte of data transferred. In this mode, the transfer rate is about 1 MB/s. Manufacturers can configure devices to support a synchronous protocol that sends data bytes at fixed intervals without handshaking; this method achieves a rate of 3 to 4 MB/s.

A large portion of the SCSI standard describes the command set that the initiator uses to request services from the target. Table 3 lists the commands for read/write disk drives. For each type of device, the commands divide into four types: mandatory, extended, optional, and vendor-unique.

All SCSI implementations must support mandatory commands. The extended command set supports devices of higher capacity and enables self-configuring software drivers dynamically to determine the characteristics of extended-mode devices. Optional commands add functionality but are not required for conformance to SCSI. The standard does not specify vendor-unique commands, but manufacturers can define them as appropriate.

The data space of a SCSI device is organized logically as a linear array of blocks. Data-transfer commands specify a logical block number and the number of blocks to transfer. The mandatory set of commands allows 21 bits for the block address (about 2 million blocks) and 8 bits for the block count; the extended set uses a 32-bit block address and 16 bits for the block count. The maximum length of a block is 16MB in the mandatory set and 4GB in the extended, yielding theoretical maximum capacities on the order of 10^{12} and 10^{18} bytes, respectively. The realities of host software on one end and peripheral construction on the other limit actual capacities.

APPLES AND TENNIS BALLS

Comparing SCSI with ESDI is like comparing apples with tennis balls. SCSI is not a hard-disk controller, but rather a bus, with a command set, that connects a computer to the actual hard-disk controller located on the peripheral, which

SCSI II IS DUE

An ANSI committee is currently working on the final draft of the standard for SCSI II, known officially as X3T9.2/86-109. ANSI intends for this new standard to remain hardware- and software-compatible with the current SCSI standard (SCSI I), while at the same time offering dramatic improvements in speed and capabilities. One indication of the magnitude of changes suggested to the current standard is the sheer size of the draft document—more than 500 pages, compared with 212 for SCSI I.

In SCSI II, major hardware changes are made in the bus width and maximum data-transfer speed. SCSI II remains compatible with SCSI I's 8-bit data path, but also offers 16- and 32-bit data paths. Maximum data-transfer rate is increased to more than 10MB per second, up from 3MB to 4MB per second, the maximum currently possible.

Another important addition is command queuing, which permits multiple commands to be sent at one time to a single SCSI bus target. This saves time because a device can parse a second command while the previous one is executing. The new standard also contains a SCSI command set specifically for CD-ROMs. These devices have been difficult to program because, unlike disk drives, they do not have a consistent data block size. Other improvements include enhanced automatic configuration capabilities and improvements in the copy commands (which in SCSI I sometimes operate improperly when copying between devices with different block sizes).

Many SCSI features that are now specific to particular implementations will become part of the SCSI II standard. Once the new standard is approved and implemented, the industry will enjoy not only much better performance but, perhaps more importantly, a much higher degree of compatibility among manufacturers. If the present timetable is observed, final approval could come as early as the summer of 1989.

—Peter G. Aitken

could—theoretically—be an ESDI controller. The two standards were designed for quite different purposes.

When selecting a high-performance, hard-disk system, your choice will be between ESDI and SCSI. Hardware specifications, such as data-transfer speed, are only part of the comparison. The choice of interface affects system design in many other ways.

The *maximum data transfer rate* of an interface is the fastest rate the interface transfers data between the computer and the hard disk under ideal conditions—that is, when neither the computer nor the hard disk slows the system down. In this measure, ESDI and SCSI are, for all practical purposes, equivalent. Current implementations of both operate at 10 MHz, or 10 million bits per second (Mbps), which, at 8 bits per byte, translates to 1.25 MB/s. Not all of these bytes are user data, however (some are error correction code and address marks), so these speeds translate into a maximum data-transfer rate of just less than 1 MB/s.

Accessing a hard disk involves more than the data transfer itself. The interface must translate commands from the operating system or application program into signals that control the hard-disk hardware. With ESDI, this is a one-step process performed by controller circuitry on the host adapter.

SCSI, on the other hand, requires two steps. First, the host adapter converts the operating system commands to SCSI bus commands. Then, the circuitry on the hard disk converts the SCSI bus commands to hard-disk control signals. This SCSI processing overhead gives ESDI the edge in raw transfer rate; thus, other factors being equal, ESDI takes slightly less time to read or write a given disk file.

SCSI, however, offers its own benefits. Two advantages result from its configuration, which places separate controller circuitry directly on each hard disk (or other peripheral). For one, the developer can select the best controller design for each drive, rather than relying on a generic central controller that might not match exactly the characteristics of different drives. For another, the data lines between controller and drive are less subject to noise because they are so short.

A more fundamental SCSI advantage is that, for a high-level subsystem, it has a fair amount of stand-alone intelligence. The command structure permits fairly complex transfers between SCSI devices on the same bus, once started, to proceed without the host intervening further. Thus, a hard disk can be backing up to tape while the computer goes about other business; or transfer requests can be given some priority other than arrival time, so that a lengthy transfer could be interrupted to perform a shorter one.

Another SCSI advantage is that it connects as many as seven targets to a single SCSI host adapter. The daisy-chain configuration makes cabling relatively simple. Theoretically, any SCSI device can connect to a SCSI port; this includes hard disks, tape drives, CD-ROM players, scanners, and write-once-read-many (WORM) drives. Devoting one precious expansion slot (are there ever enough?) to a SCSI host adapter is an exceptionally effective way to maximize the unit's expansion capabilities. If you are a real peripheral hog, you can put as many as four SCSI host adapters in one system unit.

Although the ESDI specification allows for devices other than hard disks, and for connecting as many as seven devices to one controller, all current PC implementations are limited to two hard disks (for no particular reason).

On the surface, SCSI seems to be the hard-disk interface of choice for all systems except single-user configurations in which every iota of hard-disk speed is more important than expand-

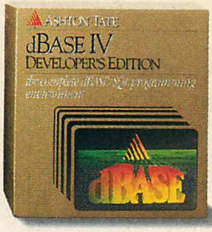
TABLE 3: ***SCSI Commands for Direct-access Devices***

CODE	TYPE	COMMAND
00H	O	Test unit ready
01H	O	Rezero (seek to track 0)
03H	M	Read status
04H	M	Format
07H	O	Remap sectors per defect list
08H	M	Read data (21-bit address, 8-bit count)
0AH	M	Write data (21-bit address, 8-bit count)
0BH	O	Seek (21-bit address)
12H	E	Inquiry (get unit type)
15H	O	Mode select (set drive parameters)
16H	O	Reserve (lock) unit or extent
17H	O	Release (unlock)
18H	O	Copy data (same or different units)
1AH	O	Mode sense (get drive parameters)
1BH	O	Start or stop drive
1CH	O	Read diagnostic results
1DH	O	Request diagnostics
1EH	O	Prevent or allow medium removal
1FH	—	Reserved
25H	E	Read capacity or free space
28H	E	Read data (32-bit address, 16-bit count)
2AH	E	Write data (32-bit address, 16-bit count)
2BH	O	Seek (32-bit address)
2EH	O	Write with verify
2FH	O	Verify
30H	O	Search for data high
31H	O	Search for data equal
32H	O	Search for data low
33H	O	Set extent limit for next series of accesses
34H–38H	—	Reserved
39H	O	Compare data
3AH	O	Copy with verify
3BH–9FH	—	Reserved

Codes not listed are available for vendor-unique commands.

M = Mandatory for base SCSI implementation
E = Required for extended implementation
O = Optional in either implementation

The extended command set supports self-configuring driver software and allows devices of higher capacity than the mandatory set. Many manufacturers use the undefined command codes for implementation-specific commands, which causes incompatibilities among various SCSI units and diminishes SCSI interchangeability.



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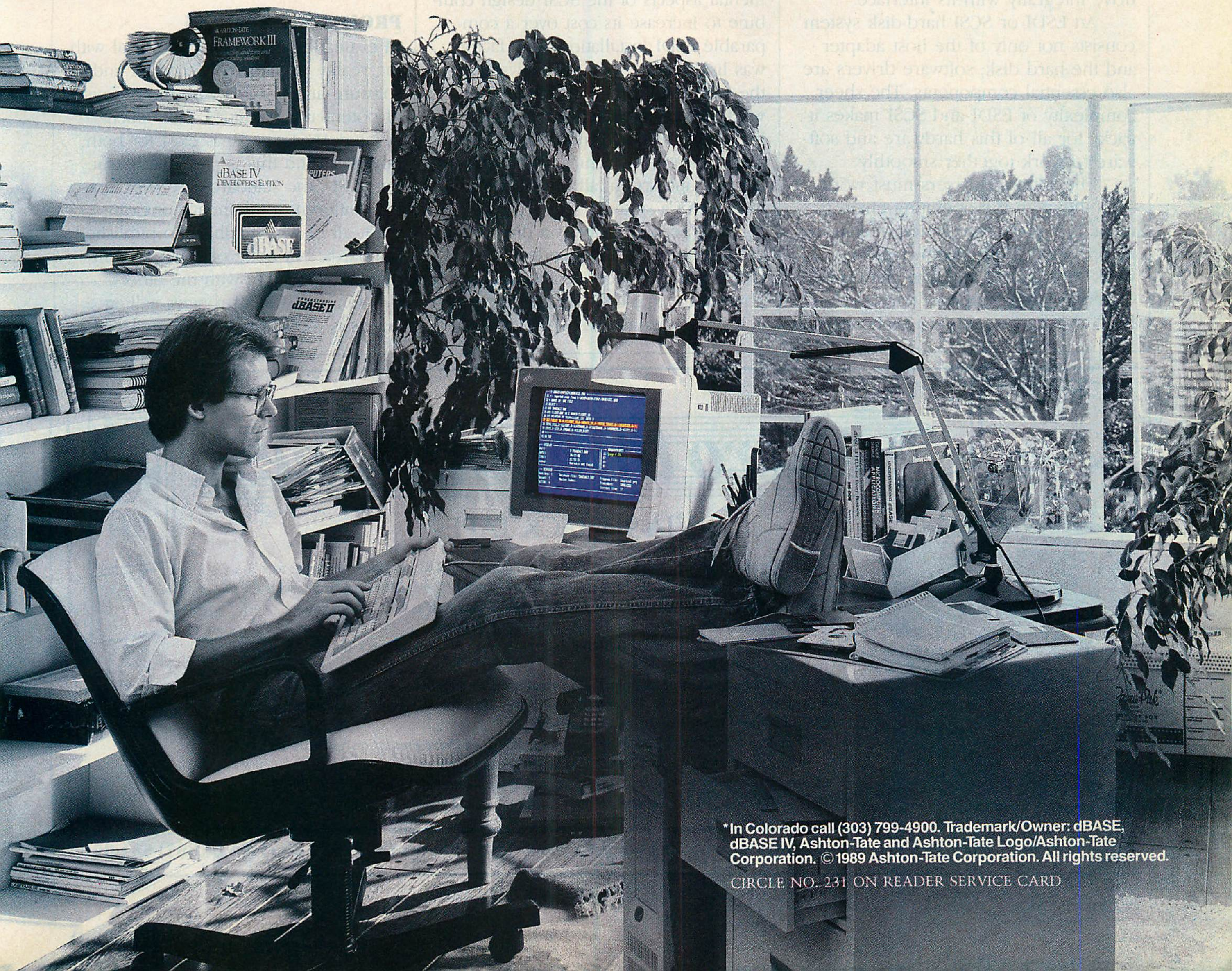

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ability. This conclusion is justified if based solely on the idealized specifications and abilities of each interface.

Developers and integrators know, however, that a functional system is not constructed out of idealized specifications. The realities are what is commercially available, how much it costs, which system software it works with, and so on. In the real world, an intelligent choice of hard-disk interface is more than simply choosing between ESDI and SCSI on the basis of design; other factors are involved.

To digress momentarily, the ST-506 interface is relatively simple and has been around for many years. Standards have evolved, so when you purchase an ST-506, you know exactly what you are getting. One manufacturer's ST-506 controller will work with a variety of hard disks—witness the many Adaptec, Western Digital, and Xebec controllers that run CDC, Miniscribe, Rodime, and Seagate disks in millions of XTs and ATs. With the new interfaces, however, a vendor must design an ESDI or SCSI drive integrally with its interface.

An ESDI or SCSI hard-disk system consists not only of the host adapter and the hard disk; software drivers are also essential components. The sheer complexity of ESDI and SCSI makes it tricky for all of this hardware and software to work together smoothly.

The software drivers must work smoothly with the operating environment. A mass-storage system that works perfectly well with 3Com might not work with Banyan because software drivers are not available. For OS/2, BIOS drivers burned into on-board ROM are useless; a disk system needs protected-mode drivers implemented either in IBM's ABIOS firmware or entirely in software.

Besides the potential problems with systems software, the question of compatibility with applications arises, especially disk utilities. No problem should arise where these utilities limit disk access to methods officially sanctioned by the operating system or at least the BIOS; however, programs behave differently. A benchmark that times track-to-track access could produce unexpected results if it steps by logical tracks and if the logical track does not correspond to a physical track. (In the 120MB ESDI disk of the PS/2 Model 70-121, when the software driver steps by one track, the read/write heads move across eight physical tracks, understating this aspect of the disk's performance by a factor of 8.)

MORE TRADE-OFFS

Various factors give the cost advantage to ESDI. To be specific, three fundamental aspects of the SCSI design combine to increase its cost over a comparable ESDI installation. One factor was listed above as a SCSI advantage: the SCSI intelligence. In the digital world, more intelligence means more logic elements, and more logic elements mean more chips, more printed circuits, and so on, all of which add to the cost of a system.

The second factor is a direct result of SCSI being an independent bus rather than a device-specific interface. This means that each computer-peripheral link contains two separate interfaces, one between the computer's bus and the SCSI bus, and one between the SCSI bus and the peripheral controller.

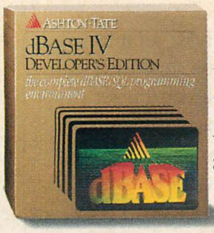
The third factor has to do with internal versus external mounting of peripherals. ESDI hard disks are, almost without exception, mounted inside the system unit where they share its case and power supply. SCSI hard disks can be mounted internally, but external mounting is necessary to take advantage of the interchangeability of SCSI peripherals (which is, after all, one of its selling points). An external peripheral must have its own case and power supply; this adds to the cost.

Planning ahead can impact overall cost effectiveness. For a two-disk network file server that will be locked in a closet for the next five years, ESDI interface disks may indeed save money. If, on the other hand, you are designing networked workstations for a growing firm, spending a little more on SCSI now can save money down the road when your client adds scanners and optical drives to each station.

PROMISES, PROMISES

In evaluating either interface, deal with the reality of available hardware and software and not just with the promise of potential capabilities. Fully documented ANSI standards exist for both; however (and this is particularly true for SCSI), the standards are very flexible. Different implementations can exist, all of which adhere to published standards, but none of which is completely compatible with the others.

One of SCSI's strongest selling points is the ability to plug any SCSI



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peripheral into a SCSI host adapter and be off and running. Thus, not only can you attach as many as seven target devices to a single SCSI port on your PC, but also, theoretically, you can move a SCSI hard disk and its data between computers—and not just from PC to PC, but from PC to Macintosh, PC to VAX, and so on.

This connection between computers, although true in theory, is not necessarily so in practice, for two reasons. First, SCSI buses come in two different flavors—single-ended and differential. Second, the command set is so loosely defined that any manufacturer can radically redefine it by implementing a set of unique commands. You cannot assume that a SCSI peripheral from one vendor will function on a SCSI host adapter from another vendor.

If you are planning to hang a lot of different peripherals on your SCSI port, look for a vendor that supplies not only the host adapter, but all the peripherals you need as well. Purchasing all components from one vendor minimizes incompatibilities. Price, in this situation, becomes a secondary consideration. If you do mix hardware from different vendors, be sure to test for compatibility.

Speed improvements are imminent for both interfaces. SCSI chip sets with double and quadruple the transfer rate of current hardware are currently in the prototype stage, as are ESDI controllers that operate at 15 MHz and 24 MHz instead of the current 10 MHz.

Which is better, ESDI or SCSI? A definitive answer is impossible. A look at what the industry is doing is no help either—it is a mixed bag. Some manufacturers supply only one type or the other, but most supply both, indicating that the market has shown no marked preference for one or the other. Selecting a high-performance, hard-disk interface is not as simple as deciding between ESDI or SCSI. Developers must determine which specific mass-storage implementation will work best in an individual operating environment, including the hardware, the network, the operating system, plans for future expansion, and so on. No simple task, but then, progress and simplicity seldom go hand-in-hand.

Peter G. Aitken, Ph.D., is an assistant professor in the physiology department at the Duke University Medical Center in Durham, North Carolina, where he uses IBM PCs extensively in his research. As a freelance consultant and programmer, he has written and marketed laboratory software.

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BASIC

Libraries for BASIC

Integrated compilers such as Microsoft's QuickBASIC have turned the popular language into a serious development environment—complete with prepackaged subroutine libraries. The right subroutine enables developers to take BASIC even further.

JUSTIN J. CROM

BASIC is coming of age. Always the most widely used microcomputer language, it is now a bona fide software development environment. Factors in its transition from amateur to professional are numerous extensions to the original language: optional line numbers, multiline structured programming constructs, record structures, named subprograms with parameters, and local variables.

Even more significantly, with the advent of Microsoft QuickBASIC, a developer can build a BASIC application from separately compiled modules, some written in other languages (see "BASIC Face-off," Justin J. Crom, September 1987, p. 136). Now, just as with the other language leaders, developers can choose from among several commercial subroutine libraries that provide ready-made solutions to common programming tasks.

Among the leading BASIC libraries available today are QuickPak Professional 1.23 and QBase 2.23 from Crescent Software, ToolKit 4.0 from Exim Services Inc., ProBas 2.0 from Hammerly Computer Services, Finally! Subroutine Library and Finally! Modules from Komputerwerk Inc., and The Screen Generator 4.7 from The West Chester Group. All of these products are supplied as object-code libraries for linking into applications; they are intended for BASIC compilers that support separately compiled modules (QuickBASIC 4.0 or later and BASCOM 6.0). Some are available for earlier versions of QuickBASIC; The Screen Generator can be used with Borland's Turbo BASIC, IBM Interpreted BASIC, and several other compiled languages. Developers can distribute applications created with any of these libraries without paying any royalties.

Measuring the relative merit of such tools invokes the classic make-versus-buy dilemma. A developer starting his own software shop may have more time than cash to invest. In a corporate environment, on the other hand, the library's cost may be insignificant compared with the demands on a programmer's time. Yet, economics is not the only criterion. Some developers build everything from scratch to control all aspects of their programs. They use a library only if it includes source code for all routines.

BASIC libraries include tools ranging from the insignificant to the ambitious—from routines to convert temperatures between Fahrenheit and Celsius scales or angular measures between degrees and radians (which are barely more lengthy than calling and linking external conversion routines) to those for data entry, sorting, file I/O, and record management, which enable the construction of fairly sophisticated databases. Where the requirements of an application call for a customized database rather than a commercial data manager, a library of such database routines gives the developer a significant head start over coding everything in-house.

The most useful subroutine libraries are those that automate common tasks. Virtually all programs, for example, solicit user input and then display the results of processing; thus, many libraries offer screen generators to cre-

ILLUSTRATION • NENEAD JAKESEVIC and SONJA LAMUT

TABLE 1: ***Comparison of Library Services***

	CRESCENT SOFTWARE		EXIM	HAMMERLY	KOMPUTERWERK		WEST CHESTER
PRODUCT	QuickPak Professional	QBase	Standard ToolKit	ProBas	Finally! Subroutines	Finally! Modules	The Screen Generator
VERSION	1.23	2.23	4.0	2.0	4.0	4.0	4.7
PRICE	$149.00	$149.00	$99.95	$135.00	$99.00	$99.00	$79.00
SOURCE CODE							
BASIC	●	●	○	●	●	○	○
Assembly language	●[a]	●[a]	○	○	●	○	○
SERVICES							
Array handling	●	◐	○	◐	●	○	○
Data management	○	●	●	○	○	○	○
Data entry by field	●	●	●	●	●	○	○
Data entry by form	○	●	●	○	○	●	●
Date and time functions	●	◐	●	●	●	○	○
DOS services	●	●	●	●	●	●	○
Dynamic string arrays	●	●	○	●	○	○	○
EMS support	○	○	○	●	○	○	○
File services	●	◐	●	●	○	●	○
Financial functions	●	○	○	○	○	○	○
Graphics and video services	●	●	◐	●	●	○	○
Keyboard control	●	○	○	◐	●	○	○
Mathematical functions	●	○	○	○	●	○	○
Menus	●	●	●	○	○	●	○
Mouse support	●	○	○	●	○	○	○
Numeric conversions	●	○	●	●	●	○	○
Pop-ups	●	○	●	○	○	○	○
Sorting	●	◐	●	◐	●	○	○
Statistical functions	●	○	◐	○	○	○	○
String processing	●	◐	●	●	●	○	○
Window management	◐	○	●	●	○	◐	○

● = Yes ○ = No ◐ = Partial or Limited *[a] = Available on request at no extra cost.*

Any of these libraries is a fine choice for adding to a BASIC development environment. Developers can answer individual programming needs with the specialties addressed by one, or purchase a couple and take advantage of the best of each.

ate and display formatted screens and to facilitate data entry and editing. Input validation procedures and formatting capabilities built into the routines protect the application from "creative" end-user input. Data-entry routines for validating interactive input are usually quite complex, and hand-coding them is time-consuming and error-prone.

Furthermore, specialized routines can improve the look and feel of an application. Menu-driven command structures are passe; windowing and pop-up/pull-down menus with bounce-bar highlighting are now de rigueur. With several of these libraries, including these features is relatively painless.

Error handling is another target area for canned routines. Many of BASIC's built-in operations require ON ERROR coding to handle errors and guard against program failure; but ON ERROR coding and its implied branching lengthen a program, slow its execution, and convolute the logic.

Several of the libraries replace standard BASIC functions with routines that return numeric error codes, which simplifies error handling. In addition, enhanced array handling, string processing, and mathematical routines are provided. Table 1 compares the overall services that each of the seven BASIC libraries reviewed here offers in its repertoire.

A BASIC REFERENCE SHELF

Terrific, time-saving tools aside, a commercial package must be easy to use. Experienced programmers will write their own code rather than use a commercial module that is cumbersome and counter-intuitive. In addition, including too many general features can make a module too large for a particular application.

Documentation is especially important to a package that includes several hundred routines. The developer should not have to search through a manual to discern proper calling syntax from scattered, obscure clues. A manual with concise examples showing the implementation of routines greatly increases the likelihood that a developer will apply them. Sample programs on diskette showing complete use of a routine are also worthwhile, not only for instructional value, but also for copying the code directly into the program being developed.

Getting the most out of these products requires moderate familiarity with the linker and object-module librarian. This is especially true for combining routines from several toolkits to create specialized libraries for use either within the QuickBASIC environment or in a separate link step. Some of the toolkits reviewed describe linking and library functions thoroughly, but others presume the developer's knowledge of the functions.

PC Tech Journal compiled and ran the sample programs provided with

each package. Selected routines were exercised in hand-coded test programs. The purpose was not only to determine if the routine performed its intended function, but also to verify the calling sequence described in the documentation. Libraries were tested with QuickBASIC 4.0 on a Compaq Portable III and 386 Portable, both running Compaq's DOS 3.31.

Without exception, the routines performed properly, but several times the documentation contained errors for calling sequences. Finally, each vendor's technical support was evaluated on the basis of at least one call for assistance; in the absence of real problems, reasonable hypothetical questions were posed to gauge the promptness and quality of response.

Crescent Software. QuickPak Professional and QBase are high-quality products that address a wide spectrum of development problems and could prove useful to engineers and corporate PC support staffs as well as professional developers. QuickPak Professional is a collection of general-purpose routines useful in any application, while QBase is a more specialized library of database and screen-entry routines. Less-experienced programmers can benefit from the instructional quality of the documentation and sample programs.

QuickPak Professional comprises 237 assembly language routines and 84 BASIC subprograms and functions provided on three 360KB diskettes. Crescent provides source code only for the BASIC routines (assembly language source code is available on request at no charge). Versions are available for QuickBASIC 2.0 and 3.0. QuickPak Professional includes routines for array handling, DOS services, math, video, string processing, pull-down menus, mouse support, and graphics dumps to Epson and Hewlett-Packard LaserJet printers. Several major program components also permit adding the functionality of a text editor and spreadsheet to an application.

The package's extensive array-handling capabilities include assembly language routines for filling arrays or portions of arrays with values, deleting and inserting elements, searching for string matches (with or without case sensitivity), and finding maximum/minimum. The sorting routines are quite flexible, providing both ascending and descending sorts in addition to case-sensitivity options.

Many of the DOS services in QuickPak Professional duplicate functions available in BASIC. Each QuickPak routine returns an error flag that the calling program can test immediately, rather than use ON ERROR and its attendant branching. The result is faster, more compact programs.

QuickPak Professional's BASIC routines include four math functions not provided in the standard QuickBASIC 4.0 suite: arc cosine, arc sine, four-quadrant arc tangent, and the trivial log base 10. Developers can use the financial functions (rate of return, present value, depreciation, and annuity) as provided or can easily customize the BASIC code.

Video services include several box-drawing routines, screen save/load capability (including EGA and VGA support), screen-painting routines that do not wipe out text, and scrolling. Noteworthy menu routines include a multi-column menu program (in addition to Lotus-like horizontal and Microsoft pull-down menus); a routine that emulates QuickBASIC's file-selection menu; and another that allows multiple choices, returning the number of items chosen and the identifier of each. Menus respond to keyboard or mouse.

Crescent Software's QuickPak Professional includes extensive array-handling capabilities and flexible sorting routines.

The menus boast a multitasking mode in which waiting for user input does not suspend the program. In this mode, the program continues to run after displaying the menu, periodically polling the menu to determine if the user has made a selection. When the program detects user input, it suspends the multitasked procedure and then branches to the procedure associated with the menu choice.

QuickPak Professional has a straightforward window manager that frees the developer from maintaining shadow images of video buffers. One attractive feature is that opening a window is nondestructive—the routine automatically saves the portion of the text screen that the window occupies to an array before opening the window. Closing the window restores the original screen contents. Displaying text requires the calling program to keep track of the window size to prevent it from overflowing its boundaries.

The package's string-manipulation routines include encryption, character and string replacement, case conversion, and a clone of BASIC's ASC that handles null strings without error. Some routines strip control characters and replace extended box-drawing characters with normal ASCII characters, prior to sending text to a printer. QuickPak Professional provides a replacement for BASIC LEN that is compact and saves significant space in string-intensive programs.

Given QuickBASIC's medium memory model, data memory is a limited resource that programmers manage carefully. For programs run as .EXE files, QuickBASIC allocates a single 64KB segment for all strings, numeric scalars, and static arrays. A string-intensive program quickly pushes the limits of this space. However, QuickBASIC stores dynamic numeric arrays outside the default data segment. QuickPak Professional contains routines to move the data back and forth between string arrays and dynamic integer arrays in order to free string storage space. Then, BSAVE quickly writes the resultant integer arrays to disk.

QuickPak Professional's text editor and spreadsheet subprograms are no match for WordPerfect and Lotus 1-2-3. Nevertheless, they are quite useful in interactive applications where the end user might append notes describing a particular case study or perform some intermediate calculations.

The Crescent documentation is well written. Bound with a plastic comb, the main documentation (about 350 pages) is accompanied by a 62-page primer on assembly language and a booklet that includes tips and techniques for BASIC programming. Instructions on using the QuickPak Professional routines do not assume an intimacy with the linker and librarian, and thus form an excellent tutorial that also serves as a superb companion to QuickBASIC 4.0 manuals.

The manual's organization is rather curious, however. A reference section, in which the various routines are grouped by function rather than alphabetically, follows an introductory tutorial. Additional tutorial material follows the reference section. Crescent should pull together the tutorial sections and add tabs for each functional category. In addition, the volume has no index, and the table of contents has incorrect page numbers. The missing index is

especially frustrating with Crescent's frequent use of the phrase, "explained elsewhere in this manual," without a clue as to where to look.

Developers are compensated for the failings of the manual somewhat by the numerous sample programs that illustrate using the routines. Comments within these programs offer additional instruction and reinforcement of points made in the manual.

In addition to QuickPak Professional, Crescent offers other collections of BASIC programming tools, including QBase, a library of routines for implementing relational data management systems. QBase is distributed on two 360KB diskettes; it is not necessary to have QuickPak Professional in order to use QBase routines.

As a stand-alone data manager, QBase does not threaten dBASE and its ilk; the library will interest developers whose clients require a customized data manager embedded in another application. QBase handles four related files in addition to the main file with no limit on the number of related fields between files. The package incorporates the essentials of relational data management except for a report writer, leaving that task to the developer. By providing QBase as a library of individual routines, Crescent encourages use of its fine data-entry and screen-management capabilities in applications other than data management.

The QBase screen design and management facility uses on-screen layout. The comprehensive pull-down menu system permits rapid composition of data-entry screens, including control over colors and validation tests for input fields. Developers set default values by entering them in the field during design, and can define fields as multiple choice, presenting the user with a menu of the options acceptable as input to the field.

Developers can flag fields for indexing to promote rapid searching. QBase encodes string fields by converting the first two letters of the field into an integer index. An interesting feature of QBase indexing is that QBase tailors the index arrays to the system upon which the final application will run. If multiple indexes are defined and would overtax the memory of the target system, QBase loads only as many index files as the system's memory will hold. The penalty paid for such specialization is slower searches.

The screen design used in QBase readily incorporates various types of boxes and lines, and the developer can create custom help screens. The screen-generation program also has facilities for the creation and maintenance of screen libraries.

Calls to the QBase component subprograms display the screens and present data-entry forms. The calling sequences are logical and intuitive. The data-entry manager validates user input according to the criteria chosen by the developer during screen design. The manager returns valid data to the calling program via an array with one element per data-entry field; it determines whether the user actually changed the input screen and notifies the calling program accordingly.

As with QuickPak Professional, informative examples accompany the QBase BASIC source code. The QBase documentation is a spartan 80-page pamphlet, but it is well written and does lay out QBase fundamentals. The descriptions of many individual routines, however, are cursory at best and require examination of sample program code—fortunately, the programs are well documented internally. Crescent personnel answered test calls made to the company's technical support line immediately and provided knowledgeable support.

Exim's ToolKit has routines to handle video services, DOS, data management, memory management, and date arithmetic.

Exim Services of North America Inc. Exim's ToolKit addresses a variety of professional development needs, but could also interest part-time programmers. Exim's documentation, however, offers only a minimum of hand-holding and thus is not suited for those without considerable experience with the librarian and linker.

ToolKit's 94 routines handle a multitude of tasks, including video services, DOS environment, data management, memory management, and date arithmetic, as well as file I/O, sorting, and general-purpose conversion routines. No source code is provided. The package comes with five 360KB diskettes: two for use with QuickBASIC 4.*x*, two for IBM Compiled BASIC 2.0, and one with a sample application.

On-screen design is not supported. ToolKit's screen-management routines use screen definitions explicitly declared in a text file, an approach reminiscent of older mainframe screen-design procedures. Although workable, this technique is awkward compared with WYSIWYG systems. Because converting screen definitions to actual screen images at runtime is too time-consuming, Exim includes a program to convert the text files to a form quickly displayed by the application.

Calls to the Exim screen manager from the application program can assume several forms, depending on the desired action. Data passed by the validation process are placed into a single string and must be parsed by the application program.

ToolKit video services include windowing, pop-up messages, box draw, high-speed printing to screen, screen clearing and restoring, scrolling, and screen-print routines. Exim's versatile windowing routine handles multiple windows. Once a window is opened, successive calls to the windowing program direct subsequent printing and other operations on that window. The window destroys the text screen in the area of the window display, leaving a blank space when the window is closed. Before calling the window routine, the program must save the portion of the text screen that will be covered and then reconstruct it after closing the window.

Several routines in ToolKit provide interaction with DOS services. A program can display directory listings in a menu format, allowing the user to point-and-shoot to select files. File names can be read into arrays based on selection criteria. Another routine determines the number of files that match a file specification and the total size of those files. Other routines help the program determine the state of the DOS environment.

ToolKit also has routines to assist writing a multiuser data management system for LANs. These routines incorporate provisions for file sharing and record locking. Files can be as large as 16MB and contain as many as 32,767 records. Recognizing that the performance of the hashed indexing technique the data manager uses depends on the characteristics and distribution of data keys, Exim includes the source code for the hashing algorithm so that the developer can tailor it to the particular application.

Exim does not tie the diverse database programming elements together,

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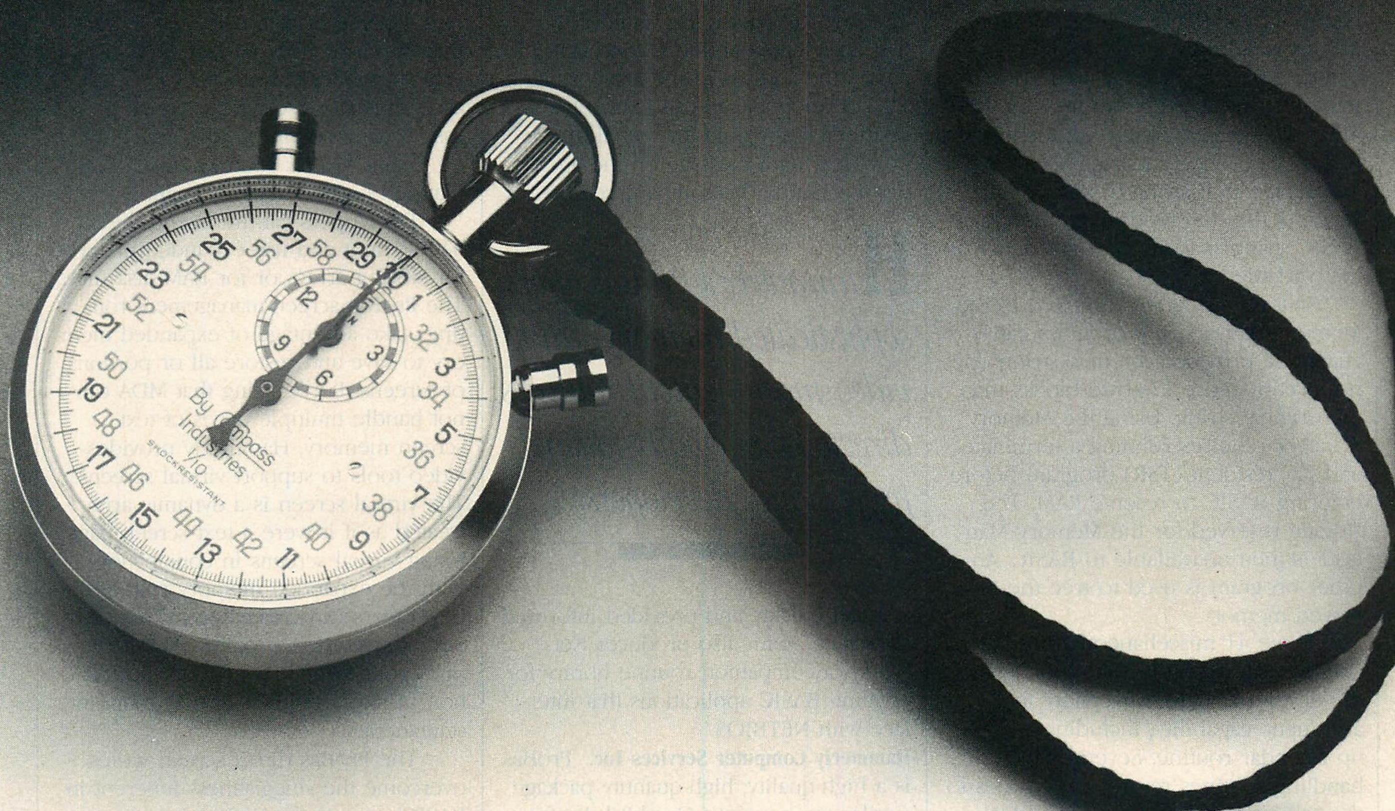

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leaving that to the developer. For example, data files are not automatically coordinated with their index files, so adding a data record does not spontaneously add the corresponding index to the index file. However, the components in the sample program adequately illustrate the implementation of the database routines.

String storage space is often at a premium, so Exim offers its Memory Manager, which lets the developer allocate as much as 256KB of additional storage for strings. Allocation occurs within the 640KB DOS limit. Memory Manager allocates string storage in 128-byte parcels. When called upon to store a string in the extra memory, the Memory Manager assigns an identification number to each string. By then assigning a null string to the string variable, the developer frees the QuickBASIC string space formerly assigned to that variable.

Once a string is committed to the Memory Manager, the program can change it, provided the new string does not occupy more 128-byte blocks than the original string. Using the Memory Manager requires running a terminate-and-stay-resident (TSR) program before entering BASIC to reserve RAM. The storage reserved for the Memory Manager is then unavailable to BASIC. Another program is used to free the reserved memory.

Some 41 miscellaneous routines complete the ToolKit. Date tools give the developer date-conversion and arithmetic capability, including a pop-up calendar routine. Several file-handling routines return error codes to the calling program, eliminating ON ERROR coding. General-purpose routines handle the sorting of integer, real, and string arrays using a modified quick-sort algorithm; string justification and case conversion; simple menus; and an error message interpreter to translate the return codes from various Exim routines. Anyone who has coded a check-writing program will appreciate Exim's routine to convert a number to its English language equivalent.

The documentation is generally good. Sections describing each of the functional categories are followed by a reference section listing descriptions of the individual routines and their parameters. Although brief, the summaries are self-explanatory. Tree diagrams showing interrelationships with other Exim routines (if any) accompany each description. A dictionary of the return codes and their messages is included. The manual assumes a familiarity with the linker and librarian. Unfortunately, the manual is housed in a loose-leaf binder holding double-sided photocopies that are prone to tear out.

The utility of the documentation is further flawed by numerous typographical errors. For example, to pass a string array A$ to a sorting routine XMSORTS, the manual says to use:

```
XMSORTS(FIRST%, LAST%, a$(1), . . . )
```

The correct call is:

```
XMSORTS(FIRST%, LAST%, a$(), . . . )
```

The first call passes the value of the first array element; the second call passes the address of the array itself.

Developers can call Exim's headquarters at any time for technical support (leaving a message on the answering machine). The company returned a test call quickly and provided informed assistance. Exim also produces NetWorks, a companion routine library for creating BASIC applications that interface with NETBIOS.

Hammerly's ProBas offers sophisticated memory- and video-management routines directed principally toward professional developers.

Hammerly Computer Services Inc. ProBas is a high-quality, high-quantity package similar to Crescent's QuickPak Professional. Containing neither financial nor scientific functions, ProBas instead offers many sophisticated memory- and video-management routines directed principally toward professional developers, but occasional programmers also will find much to like about ProBas.

All but six of the 232 routines in ProBas 2.0 are written in assembly language. The routines provide system configuration detection and manipulation, memory management, screen management, disk directory management, file handling with networking capability, and mouse support. ProBas is distributed on two 360KB diskettes.

The ProBas equipment functions enable programs to determine the configuration of the system on which they are running and to modify the operating environment. The program can determine such things as monitor type and video mode for MDA, CGA, and EGA (but not VGA) systems. Other routines check the availability of disk space and determine the presence of a mouse or expanded memory.

ProBas has a powerful set of routines to circumvent the memory restrictions of QuickBASIC and DOS. A program can move information between strings and dynamic integer arrays. While in the array, the individual strings are similar to records in a random access file.

Other ProBas routines can sort the information stored in the integer arrays. Sorting of data in larger amounts than fit in memory is possible with ProBas pointer sorts. Sorts can be in ascending or descending sequence, and case sensitivity can be toggled on or off. Other ProBas routines allow manipulating blocks of data in memory.

Developers can transcend the DOS 640KB limit and use expanded memory for storing arrays or for RAM-disk files. The ProBas screen-management routines take advantage of expanded memory to save and restore all or portions of screens. Recognizing that MDA cannot handle multiple pages of text screen memory, Hammerly provides video tools to support virtual screens. The virtual screen is a dynamic array treated as if it were a text screen page. Using virtual screens in conjunction with the expanded memory routines, developers can create several hundred virtual screens. A program can create numerous virtual screens of information in memory, then display them instantaneously.

The ProBas direct screen writes overcome the sluggishness inherent in BASIC's use of the BIOS when executing PRINT commands. Programs can perform direct printing to graphics screens with placement specified in the row/column order typical of the text screen. When printing to a graphics screen, developers can specify the height and width of characters.

Two features of the ProBas window manager are markedly different from the others in this review. First, it can open a window in a manner that makes it seem to explode onto the screen, growing to full size from a small point. The developer cannot control the speed of zooming except by tricking the program through turning snow suppression on or off. The speed of 25-MHz machines may diminish the effect of this explosion; but on many machines, it is dramatic. The other unique feature is an optional drop shadow, which produces a three-dimensional effect.

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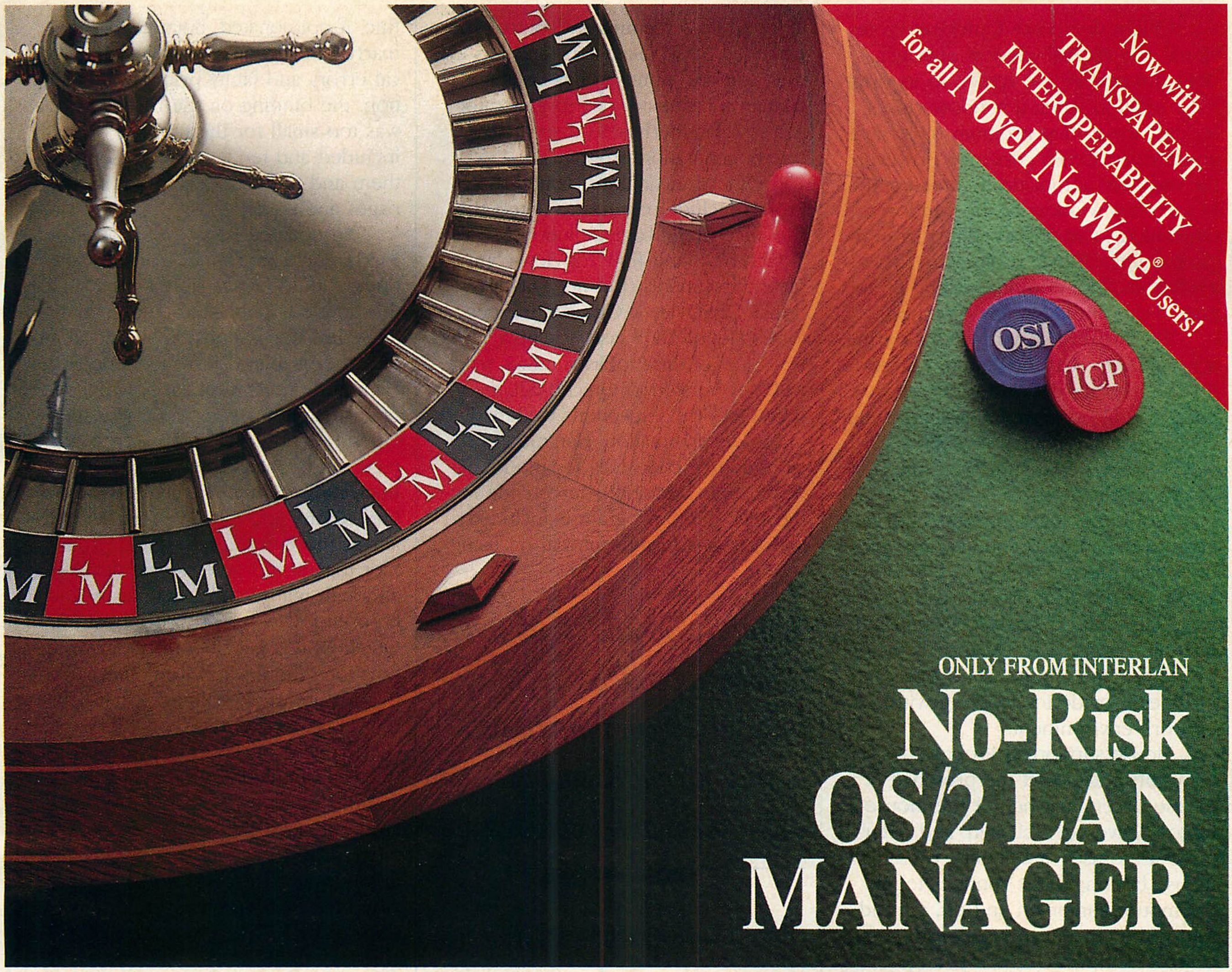

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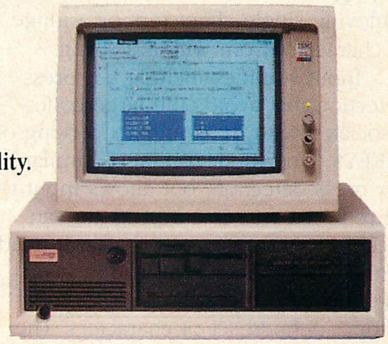

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Unlike Crescent's QuickPak Professional, the ProBas window manager does not restore the screen to its original condition when a window closes; instead, the calling program must save and restore screen contents. However, the manager automatically limits output to a ProBas window to the window dimensions, without any effort from the programmer. Other routines in the ProBas package permit scrolling of any part of the display in any direction.

The file-directory functions permit a program to read or search a directory and obtain detailed information about the file system, including system and hidden file names as well as subdirectory names. The functions support wild-card searches.

ProBas file-handling offers advantages over its BASIC counterparts: routines return error codes, so ON ERROR is not needed. The product can read or write large blocks of data at one time, resulting in faster access than is possible with native BASIC. The ProBas file routines provide for working within a network environment.

Mouse support in ProBas consists of routines to detect the presence of a mouse, ascertain whether the mouse buttons have been clicked, and determine if the user is currently pressing a mouse button. Other routines toggle the mouse cursor on and off, set and return the current mouse location, and control the mouse cursor's range of movement. The routines for positioning the mouse cursor come in two forms: one that works in either text or graphics mode using 640-by-200 column/row coordinates and another that is exclusively for text mode using familiar 25-by-80 row/column notation. Given that the majority of mouse use occurs in text mode, the ProBas text mode call greatly simplifies the creation of mouse-handling routines.

The ProBas string-processing functions perform various text-stripping functions: removing blanks from the left, right, or both ends of a string and removing single characters or a range of characters from within a string.

Input routines include key-press detection that avoids the large code associated with the familiar checking of INKEY$. One input routine is similar to key-press detection, but allows input to be redirected so that a program can accept input from a port or file instead of the keyboard. Several routines validate input by comparing it with a developer-defined set of characters. The single-field input routine permits setting default field contents, validates input while screening out control and extended ASCII characters, and lets the user edit the input. ProBas does not contain a data-entry screen generator per se (Hammerly sells a separate screen generation program).

Other functions in Hammerly's ProBas include routines to detect the presence of SoftLogic Solutions' DoubleDOS and IBM TopView-compatible environments (but not Quarterdeck's DESQview). One routine performs DoubleDOS task-switching.

Most of the ProBas routines work with any version of QuickBASIC or BASCOM, with exceptions well-marked in the documentation. Hammerly provides source code only for the BASIC routines. In addition, source code for the slick demo program is included and acts as a further tutorial on using ProBas routines. Hammerly does not sell the source code for its assembly language routines.

Finally! Modules' screen design approaches a WYSIWYG technique in providing for more sophisticated data-entry screens.

The voluminous manual is written in a chatty, first-person style with some colorful language (for example, the word *barf* replaces the word *crash*), fulfilling its author's stated goal of not being "too dry or technical." Included in the nearly 600 pages is a discussion of Hammerly's philosophy regarding BASIC programming style. This may irritate some readers—particularly those who are champions of QuickBASIC 4.0, which is the target of considerable invective; nevertheless, the novice programmer will benefit from most of the information.

The creation of QuickLibraries and linking is thoroughly covered. Nearly one-half of the manual is given to an excellent tutorial that takes the developer through typical uses of ProBas routines. The reference section lists all routines alphabetically and is illustrated with clear examples (some output produced by the examples would be welcome). The manual has both a table of contents and an index.

However, as with the other packages in this round-up, this otherwise fine, if opinionated, documentation is marred in several spots by typographical errors and faulty printing. In addition, the binding on the review manual was too small for the number of pages included and tended to grab some of them and pull loose from the back pages and cover.

An updated version of ProBas (for $135), containing more than 350 routines, should be available by the time this article is published. The new loose-leaf documentation should eliminate the problems just mentioned. Hammerly's technical support line is open between 9 a.m. and 6 p.m. EST. Questions posed were answered correctly and courteously.

Komputerwerk Inc. Finally! A Subroutine Library and Finally! Modules are aimed more at the infrequent programmer than at the professional developer, although many of the routines would be useful to either. Those despairing of QuickBASIC's paucity of built-in math functions should find Komputerwerk's math routines appealing.

Finally! A Subroutine Library (FSUB) is a collection of 194 subroutines and functions spread over five 360KB diskettes. Most of the routines are written in BASIC and are supplemented by 18 assembly language programs. Source and object code is provided for each program. Tasks addressed by FSUB include date and time conversion, file and directory control, graphics, hardware interfacing and control, math routines, number conversion, sorting routines, and string handling. Some of the routines are provided in two forms, the familiar DEF FN . . . END FN that must be incorporated into the BASIC source program, and the FUNCTION subprogram form for separate compilation.

A review of the contents reveals several unusual items. The date and time conversions include a leap year/leap century calculation in addition to the common month/day/year-to-integer variety. The package also includes text and graphics screen dump routines for Epson printers and IBM Proprinters. Of special interest are the routines for generating line, pie, and PERT (a project management/scheduling methodology) graphs. Although the output of these FSUB routines is crude relative to that of dedicated graphics programs, Komputerwerk's BASIC routines provide an interesting starting point for developers who want to write their own graphing routines.

The mathematical routines provide the developer with trigonometric func-

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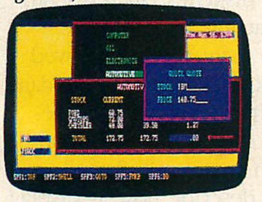

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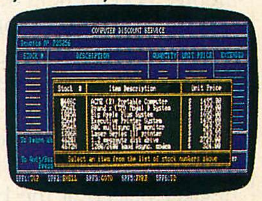

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tions that are missing from QuickBASIC 4.0: secant, cosecant, cotangent, arc sine, arc cosine, arc secant, arc cotangent. Like the native QuickBASIC functions, these additions use radians for angular measurement. Engineers and scientists will appreciate the hyperbolic and inverse hyperbolic functions, as well. In addition, FSUB includes a variety of number conversions between arbitrary bases and character strings. Completing the list of math functions is a brace of rounding routines.

FSUB's array-processing capabilities include averaging for single- and two-dimensional arrays, plus four sorting routines (using the bubble, insertion, selection, and shell algorithms) for string and numeric arrays.

Screen-control functions supply rapid centering of text, drawing boxes, clearing any portion of the screen, and saving and restoring screens. In addition, two data-input, screen-control programs permit soliciting input. The developer constructs the data input screen using print statements to locate user prompts. The program calls an FSUB input routine once per field, passing field location, length, the characters acceptable as input, and the characters to terminate input. Note, however, that this method affords only elementary input screen design.

Komputerwerk's Finally! Modules (FMOD) provides for more sophisticated data-entry screens. The FSUB library is a prerequisite to using FMOD. In addition to input screen design and management, FMOD provides routines for pull-down menus, horizontal menus, pop-up help screens, and a directory manager. FMOD is distributed on four 360KB diskettes.

FMOD's screen design approaches a WYSIWYG technique, in that it uses any text editor to place descriptive text and field locations on screen. A left bracket placed at the beginning of the field designates the field locations, and a specific *masking* code indicates where the field terminates. For example, an *N* at the end of a field signifies that the screen manager accepts only numeric input for that field.

Once the input screen is designed, the developer scans the screen layout using a special program that is provided with FMOD. The scanner converts the screen image into a table with field row/column positions, lengths, and attributes, as well as any descriptive text to be displayed. The table occupies less storage space than would the full-screen image. During this scanning process, the developer can edit some screen parameters to set the order of data entry and to change masking attributes. However, any changes to field locations and descriptive text necessitate further work with the text editor and, thus, will require rescanning.

The calls to the screen manager are simple and easy to understand. While input is under control of the screen manager, the manager checks the user input against the fields' masks and rejects the input if it is not valid. In addition to entry validation, the FMOD screen manager also places an optional, developer-defined message at the bottom of the screen that appears as the user moves to each field. Valid input is returned to the calling program in an array with one element per data-entry field, so subsequent parsing is not necessary.

Those despairing of QuickBASIC's paucity of built-in math functions should find Komputerwerk's math routines quite appealing.

The pull-down and horizontal menu modules feature Microsoft mouse support and are easy to incorporate into programs. Menu placement can be anywhere on the screen and is nondestructive, restoring the original screen when the menu is exited. The user selects from the menu using the familiar rolling bar that highlights the choices in turn, or by typing the first letter of the menu, or by pressing a function key that has been defined by the developer. The developer also specifies default choices that appear when the menu is called.

The pop-up help screen module includes two .EXE files that create help menus and combine them into binary help libraries. The menu-creation program permits control over the foreground, background, and border colors (which encourages the development of snappy displays). Five help menus can be displayed simultaneously (one library can hold as many as 99 menus memory resident); programs can use more than one library, if needed. The developer can choose to specify menu placement or leave it to the FMOD routine. Menus must be removed in reverse order to restore the original, underlying screen.

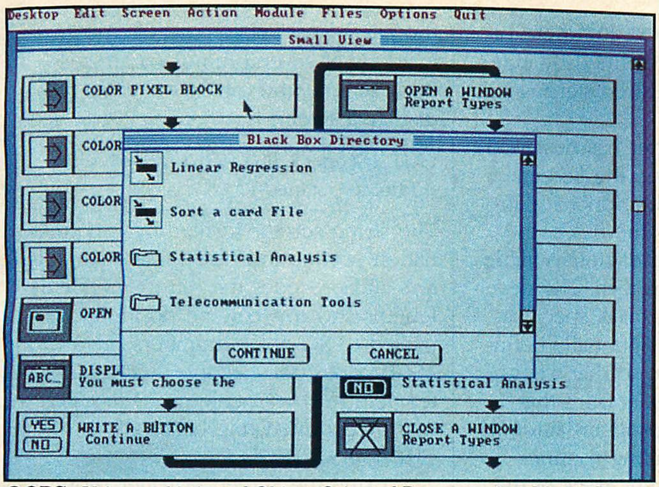
Using the FMOD directory manager module, the developer can furnish the user with DOS file-management capabilities without needing to resort to BASIC SHELL. Users are able to delete and rename files and examine a file's first page, and they can specify the drive name and directory to be searched. The directory manager displays a file listing from which the user selects a file by moving a highlight bar. The directory manager returns the selection to the calling program.

Both Komputerwerk packages come with well-organized, high-quality, loose-leaf documentation. The FSUB routines are arranged alphabetically by file name and are cross-referenced by call name, file name, and subject, which facilitates locating a routine. The FMOD documentation uses tabs to separate the sections for the individual modules. Both Komputerwerk manuals assume the developer's familiarity with both the linker and librarian.

On the down side, the FSUB manual contains some creative spellings and garbled text, which detract from its overall quality. The authors unintentionally include a degree of humor by listing the temperature-conversion routines in the section on geometry (perhaps some thermometers are calibrated in radians). The distribution diskettes contain a few assembly language routines that are not mentioned in the documentation, and, unfortunately, the manual's table of contents follows suit by listing routines that cannot be found anywhere in the documentation or on the distribution diskettes. Such discrepancies are distracting.

The FMOD manual is also flawed in that it includes sections of redundant text and tables, particularly in the description of the screen manager module. This section is severely flawed in that it does not describe how to display the screen before calling the screen manager. Fortunately, the correct calling sequence is listed in the example programs included in the package. Finally, the tabs for the menu-handling section are mislabeled (calling the procedures windowing routines).

Komputerwerk is to be commended for including source files both for the BASIC and assembly language FSUB routines. Being able to examine source code often is a great help as the developer goes about implementing the routines; in addition, it affords an opportunity to customize code. Komputerwerk also provides include files of



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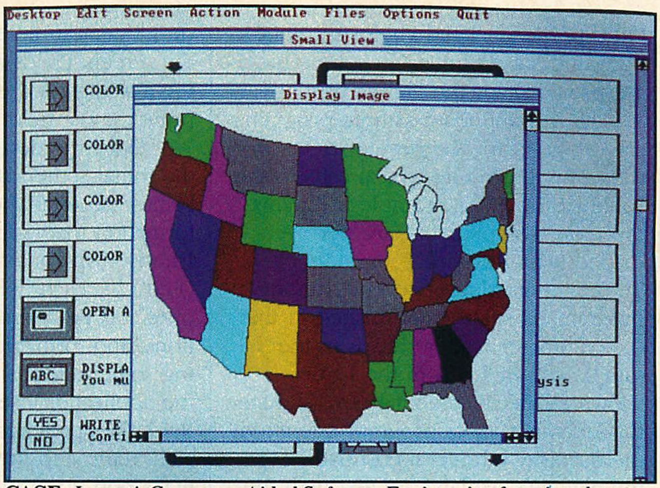

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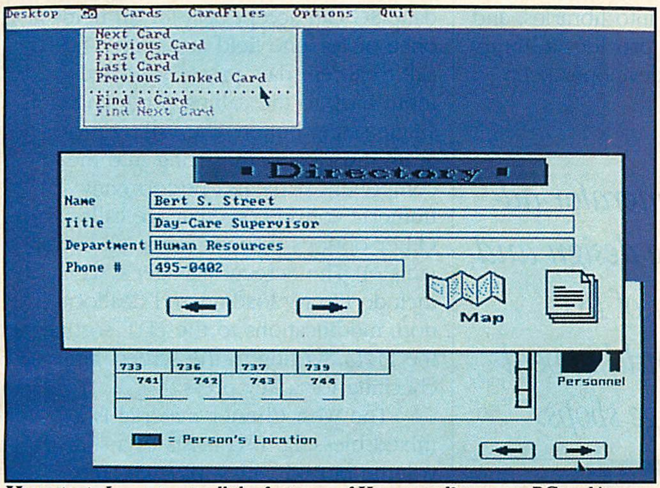

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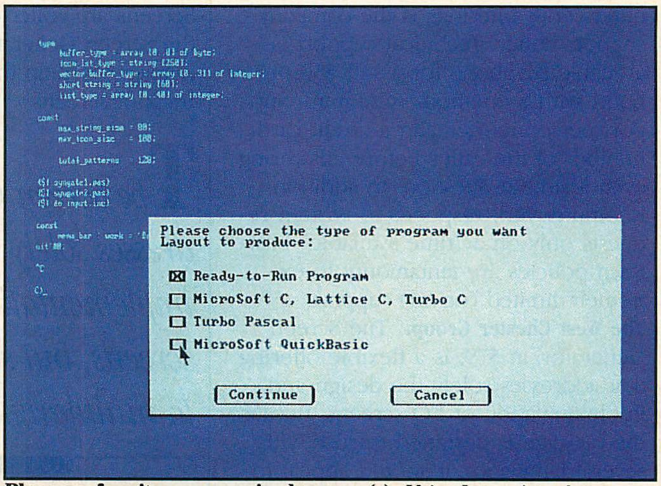

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QuickBASIC declarations for the functions and subroutines. No source files are provided for the FMOD routines.

FSUB's abundant sample programs are designed for the developer's edification by illustrating typical calls to the routine. The FMOD sample programs are more complex, but are not overloaded with gee-whiz programming. The training value of several sample programs is slightly diminished in that the parameter names shown in the sample call differ from the names shown in the documentation. Although this does not affect program operation, the disparity hinders a correlation of the manual's explanatory text with the sample program.

The greatest drawback to Komputerwerk's offerings is the company's support policy. Technical support is available by phone for a stiff $50 per hour, with a one-hour minimum. Support personnel demand a credit card number of the caller before answering even a simple question. In addition, Komputerwerk responds to written requests only on a "time available" basis. Such policies are tantamount to extremely limited (or no) support.

The West Chester Group. The Screen Generator, at $79, is a flexible offering that addresses solely the design and implementation of I/O screens. Because the package is designed for use with several languages, it should appeal to multilanguage shops.

The Screen Generator works with IBM Interpreted BASIC and Compiled BASIC (including Borland's Turbo BASIC), FORTRAN (IBM, Lahey, Microsoft), C (Borland Turbo, Lattice, Microsoft 5.*x*, Microsoft Quick), COBOL (Micro Focus, Microsoft, Realia, Ryan-McFarland), Borland Turbo Pascal 4.0, and Nantucket Clipper. The West Chester Group's package includes a separate language interface and code sample for each of these languages. Specific support for QuickBASIC consists of .BAT files to create QuickLibraries. The Screen Generator consists of two major parts, the Screen Painter and the Screen Manager. West Chester provides no source code on the three 360KB distribution diskettes.

Designing screens is straightforward using the Screen Painter program, an .EXE file that runs outside the programming environment. The developer paints a screen by selecting graphics characters and colors from menus. Comprehensive editing features permit the developer to move, copy, or delete blocks of text and color. An undo function cancels the last block function. The developer can enter text anywhere on the screen. Fields are defined by entering a # sign at the desired starting point for the field.

Once the developer has designed the initial screen layout, the Screen Painter prompts the developer for information that defines the fields; the Painter displays a field dictionary table (FDT) for each field in turn. The developer sets field length, mask specifications, and formatting, optionally defining some fields as hot, so that when the application user exits from that field, the application program automatically returns to the calling routine. FDTs pop up in different areas of the screen so as not to obscure the field in question, which is a nice touch. Screens are collected into libraries, and the Screen Generator provides a library manager to help the developer keep track of screens.

The Screen Generator addresses solely the design and implementation of I/O screens, but should appeal to multilanguage shops.

Given the relative ease with which screens can be created using this package, the routines that are used to actually call the screens were a disappointment, mainly because of the design of the calls and the documentation. The stock version of The Screen Generator requires the memory-resident program SGX.EXE to run before a call is made. Before entering the QuickBASIC environment, SGX must be resident in memory in order for the calls to work, then another .EXE file is used to remove SGX from memory.

The introduction in West Chester's manual encourages the programmer to play with the sample screens in order to get a feel for the program's capabilities; however, the manual shows a procedure that omits running SGX.EXE before entering the Screen Manager. As an alternative, the developer can purchase an optional SGX.OBJ file for $49; note that linking this file with the finished application obviates the need to install the resident version.

Calls to the Screen Manager seem unwieldy. The manual states that calls must pass only seven parameters, but the passed parameters are often concatenations of several minor parameters. For example, the call that is given to display a screen is:

```
CALL SG(oper$, lib$, scrn$, drive$, scb$,
  fdtbase$, status$)
```

The string **scb$** is formed by concatenation of nine individual string parameters and precedes the call to SG. Field lengths and row-column positions are passed to SG not as numbers but as ASCII codes; for example, a 20-character field in row 7, column 12 is specified by concatenating CHR$(20) + CHR$(7) + CHR$(12).

Using the Screen Manager requires successive calls to SG, one to display the screen and another to accept the data. SG can accept data for all fields at once or for one field at a time. The call to accept data passes validated input back to the calling program via a single string buffer. The calling program must parse the string into the component parts and perform any numeric conversions that are called for. Other options that are triggered by variants on The Screen Manager's SG call include library loading and deallocation, modifications to the FDT, sorting the FDTs, writing to the screen, and checking for a key press.

The West Chester material is a mixed blessing. It consists of a slim volume bound with a plastic comb binder. In some places, the type seems unusually small for no apparent reason. Sample calls are provided for BASIC, C, and FORTRAN. The sample program on diskette is a complex meld of menu-handling and screen-display calls that impressively displays The Screen Generator's capabilities. It would help to see sample programs showing each call as listed in the manual.

Developers inquire for technical support from The West Chester Group by leaving a message on an answering machine. West Chester personnel responded to a test call the next day, with accurate assistance to questions.

A ROUTINE DECISION

Choosing just one of these toolkits is tough because even though they overlap in some areas, each offers unique routines. Of course, developers must answer immediate and anticipated needs, but even if features overlap, purchasing several packages would permit the developer to pick and choose among the myriad options and exploit the best parts of each package.

Both Hammerly's ProBas and Crescent's QuickPak Professional combine

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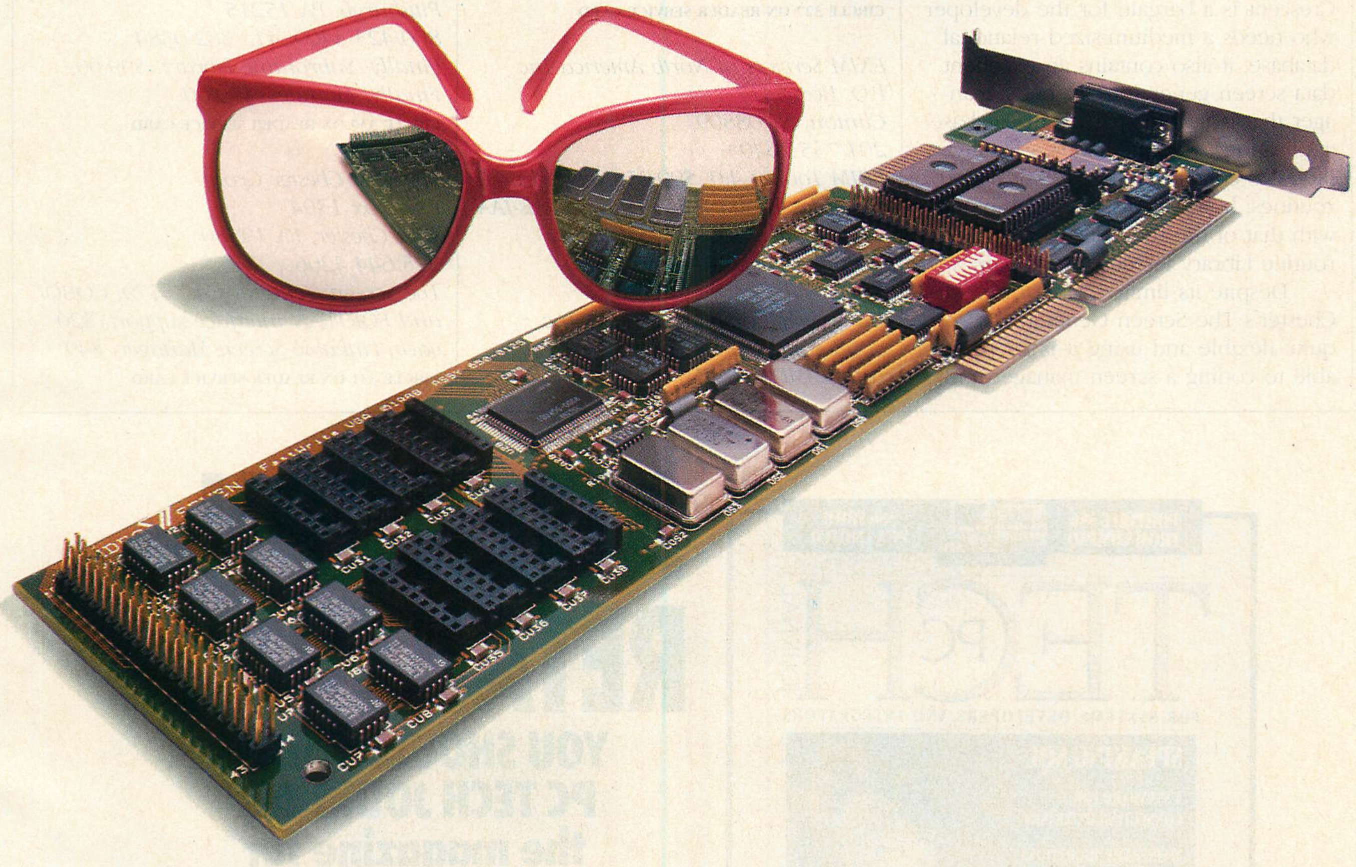

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extensive selections of efficient assembly language functions with comprehensive documentation, making them by far the best values. Professional developer and novice alike will appreciate these collections. Crescent's inclusion of source code is a definite advantage, while Hammerly's expanded memory routines and virtual screens are powerful tools.

With its less extensive repertoire and less comprehensive documentation, Exim's ToolKit is nonetheless a fair value. For intrepid programmers not intimidated by usurious support policies, Komputerwerk's Finally! A Subroutine Library also offers many useful tools at a reasonable price.

The more specialized QBase from Crescent is a bargain for the developer who needs a medium-sized relational database; it also contains an excellent data screen generator/data-entry manager that is usable apart from database applications. Komputerwerk's Finally! Modules contains some well-designed routines; however, its price combined with that of the requisite Finally! A Subroutine Library lessens the bargain.

Despite its limited repertoire, West Chester's The Screen Generator is quite flexible and using it is far preferable to coding a screen manager and data-entry routines. The Screen Generator's catholic interface could serve a developer well in a multilanguage development shop, but it is not the best choice for BASIC-only applications.

Each of these collections of BASIC tools functions well; the packages differ primarily in the number and type of functions they offer and in the quality of their documentation. Each package is a bargain considering the time it would take a developer to assemble a comparable selection of tools from scratch. With one of the tool kits, you can save yourself a lot of time (and money) and, at the same time, bring your BASIC development environment to a much higher level.

Justin J. Crom is a chemical engineer working as manager of economic evaluation for a major oil company. His most recent article for PC Tech Journal *was "BASIC Face-off," in September 1987.*

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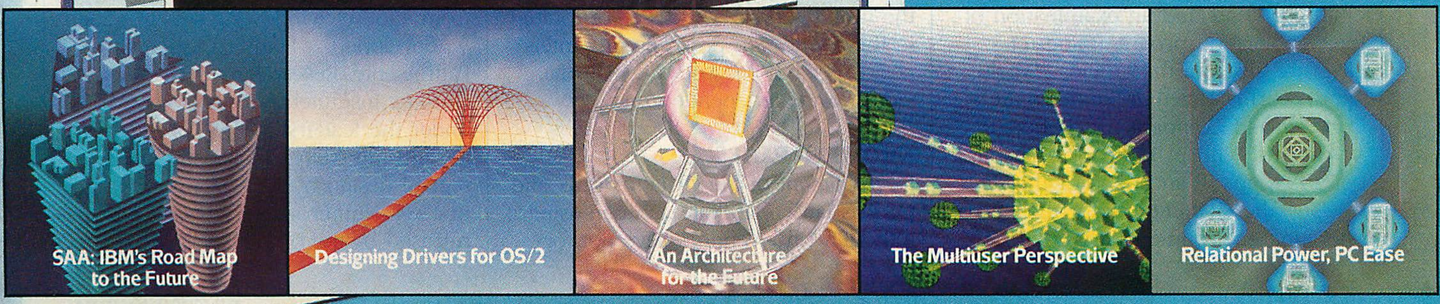


UNIX VERSUS OS/2

A Graphic Comparison

Advanced operating systems need advanced graphics user interfaces. Unix's X Window System and OS/2's Presentation Manager approach the same objective from different directions.

ROBERT R. MORRIS and WILLIAM E. BROOKS

The graphics user interfaces (GUIs) of Unix and OS/2 on the PC are the most conspicuous advanced features of these two operating systems and one of the leading end-user considerations in choosing applications. Developers who want the largest customer base need a thorough knowledge of both Unix's X Window System and OS/2's Presentation Manager.

In general, X Window comes in a variety of forms, has a skeletal programming interface, and provides a distributed network implementation, while Presentation Manager provides a consistent user interface, an extensive programming interface, and device-independent graphics for a single workstation or PC.

In this article, *PC Tech Journal* completes its comparison of Unix and OS/2 by examining their user interfaces. (A general overview of both operating systems and an examination of their application programming interfaces are given in the articles "Worlds Apart, Worlds Together" and "At the Core: An API Comparison," Robert R. Morris and William E. Brooks, December 1988, pp. 50 and 62.) For the developer, the GUI choices for these two operating environments are confusing, but the trend is clear: the graphics user interface will be de rigueur on PCs in the 1990s.

The window-based GUI—evolved from early work at the Xerox Palo Alto Research Center and refined in Apple Macintosh and Microsoft Windows—is popular for presenting complex data and improving human-machine communications. It uses graphics objects rather than text to interface with the user. Where terse text statements were once standard for giving information and abbreviated character sequences controlled the system and applications, graphics constructs are now used.

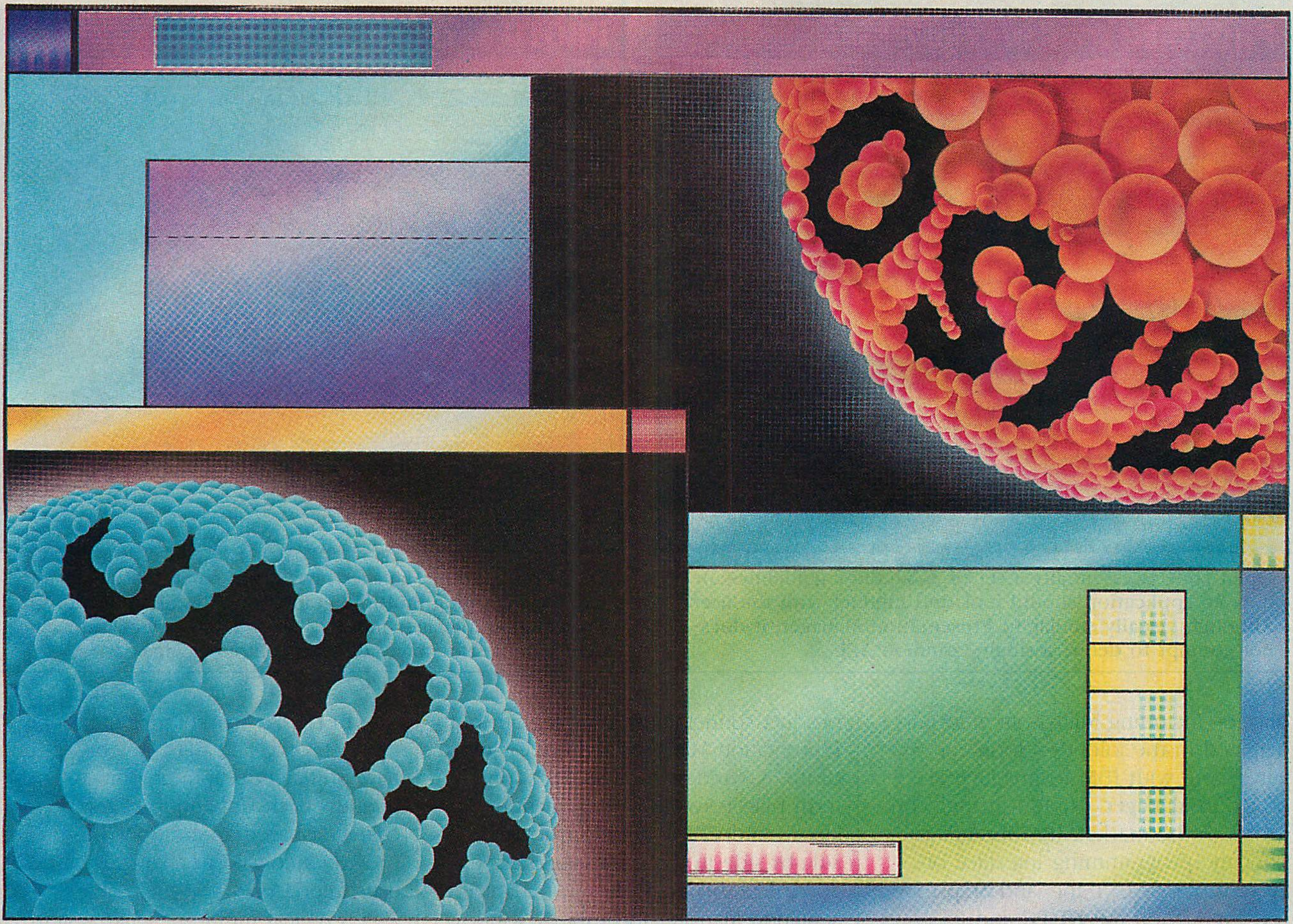
End users appreciate a standard GUI because it increases consistency among applications by allowing them to perform common functions in the same way, such as getting help, saving work, and printing results. Developers benefit from a GUI because much of the user interface work is incorporated in the application programming interface (API) and because the GUI provides device independence.

GROWING PANES

Development of the GUIs for Unix and OS/2 is fairly elaborate and confusing. Although Unix vendors have not formally agreed upon a GUI standard, the most popular at this time is the X Window System. It does not provide as complete a standard as OS/2's Presentation Manager or the Macintosh operating system, but has similar features.

X Window is a network-based windowing system. As opposed to Presentation Manager, the X Window architecture is based on the premise that an application may run on one computer while the graphics presentation of the application's output and the responses from the user can occur on a separate computer. While X Window does not contain predefined graphics functions with which Presentation Manager is so richly endowed, its modular architecture and its abundant set of building blocks can construct interfaces as powerful and complete as those of Presentation Manager.

The X Window standard descends from another windowing system, called W, developed at Stanford University by Paul Asente. Researchers at the Massachusetts Institute of Technology (MIT), under the leadership of Robert Scheifler and Jim Gettys, began the fundamental design of the X Window System in 1984. Numerous versions have been released by the original MIT Project



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Athena development partnership, whose major industry participant was Digital Equipment Corporation (DEC).

MIT released the X.11 version of X Window in September 1987 in response to the flawed X.10.4 version then in use. The X.11 release was so incompatible with X.10.4 that most application development was curtailed until X.11 became available. Release X.11.2 was introduced in March 1988, when control of the X Window standard transferred from MIT's Laboratory for Computer Science to the MIT X Consortium, consisting of representatives from Apollo Computer, AT&T, Calcomp, DEC, Hewlett-Packard (HP), Sequent, Sony, Sun Microsystems, Tektronix, and Xerox.

X Window has been embraced by many workstation and minicomputer Unix vendors as the basis for more complete developer toolkits—for example, Open Look (see photo 1) from AT&T and Sun, and DECwindows from DEC. Such products include more complete sets of *widgets* (graphics control elements such as push buttons), standards for using them, and richer sets of APIs. Where X Window does not enforce policies or well-defined methods of interoperation among applications, Open Look and DECwindows do. Although all of these toolkits are built on X Window, each delivers its own set of distinct APIs and user interfaces that are not compatible with each other.

These X Window extensions are not yet available: AT&T expects Open Look to be ready for beta testing early in 1989; DEC planned to make the user interface portion of DECwindows available to third parties by the end of 1988. (*PC Tech Journal* was unable to obtain a copy from DEC before this article went to press.)

For its part, OS/2 has been designed from the ground-up to be a workstation operating system. Its evolution from DOS has been directed toward support for presentation graphics and tools needed by developers to provide sophisticated user interfaces with their applications.

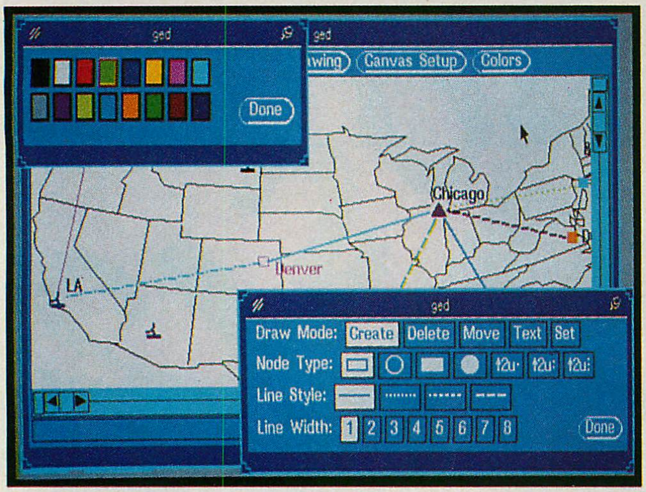
OS/2's Presentation Manager is young—announced in April 1987 along with OS/2. IBM shipped OS/2 version 1.0 in December 1987, but Presentation Manager did not arrive until almost a year later, with version 1.1 in October 1988. Presentation Manager (photo 2) is well integrated into OS/2, providing the system with windowing and application-management facilities (see "Projecting a Graphics Interface" and "The User at the Controls," Ed McNierney, March 1988, pp. 54 and 64).

Presentation Manager has a wealth of graphics constructs and tools for the developer to produce applications consistent in their use. Presentation Manager includes a full set of two-dimensional graphics functions based on IBM's Graphical Data Display Manager (GDDM) mainframe graphics standard.

OS/2's Presentation Manager reflects IBM's Systems Application Architecture (SAA) Common User Access (CUA) standards. SAA is intended to be a consistent user interface across all major IBM proprietary operating-system platforms (see "SAA: IBM's Road Map to the Future," Dennis Linnell, April 1988, p. 86). In mid-1988, IBM joined forces with other industry giants to form the Open Software Foundation (OSF) that endorsed IBM's Unix version, called the Advanced Interactive Executive (AIX). IBM is offering AIX as an alternative to OS/2 on its high-end PS/2 product line (Models 70 and 80).

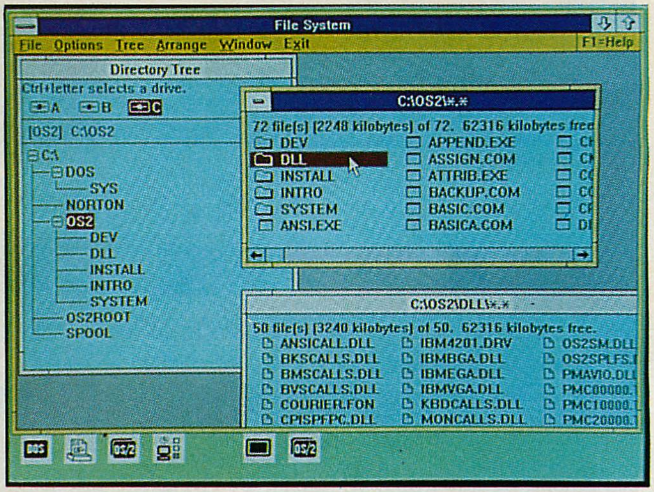
OSF also has invited proposals in an attempt to set standards for a Unix user interface, API, and network communications. In this vein, IBM finds itself competing with many industry

PHOTO 1: *AT&T/Sun Open Look*



Open Look is essentially a set of X Window guidelines for how an application should look and interact with the user. Although visually similar to Presentation Manager, it does not attempt to define a single common API.

PHOTO 2: *OS/2 Presentation Manager*



OS/2 Presentation Manager provides a consistent user interface for managing multiple graphics-oriented applications. Presentation Manager includes an API and device-independent graphics for many different output devices.

players, including Microsoft, who participated in the joint-development agreement with IBM to produce Presentation Manager. To add further confusion to the market, IBM intends to offer the programming interface of Steven Jobs's NeXT Inc. and Stepstone Inc. for AIX on the RT PC and PS/2 product line sometime in 1989.

HP, too, is developing user-interface standards. The company plans to move its NewWave environment to Presentation Manager. Originally released in March 1988 as an extension to Microsoft Windows, NewWave adds convenient features for directory and file manipulation, as well as task coordination and activation. (Apple Computer is suing both Microsoft and HP, claiming that Windows and NewWave infringes on copyrights for the Macintosh interface.) At Comdex/Fall '88, HP announced availability of its Common X Interface (CXI) that provides a Presentation Manager look-and-feel (but not the Presentation Manager API) for X Window applications. HP has submitted CXI to OSF as a proposed standard for a Unix GUI.

HP also is working with Microsoft to port Presentation Manager to Unix; the resulting environment, called Presentation Manager/X, will include the identical user interface and API used in OS/2. This is a ray of hope for developers who want GUI applications to run on both Unix and OS/2. Unfortunately, Presentation Manager/X will not be delivered soon—HP will announce availability dates and prices in the first half of 1989. Developers who want a Unix product sooner must grapple with both Presentation Manager and one or more of the X Window toolkits. HP's long-term plan is to allow Presentation Manager/X and CXI applications to run side-by-side in the same workstation. To realize this goal, HP must adapt Presentation Manager to fit the X Window server-based architecture.

Finally, several vendors are taking unique approaches to providing graphics interfaces on PCs. Architech Corporation is providing NeWS/2, an OS/2 implementation of Sun Microsystems' Unix-based Network-extensible Windowing System (NeWS). Using NeWS/2, developers with a significant investment in the NeWS system can easily port their workstation applications to OS/2. Control Systems Inc. offers a product for using PCs in the X Window environment. Its Artist Designer 12 board comes with a software driver that allows an AT-compatible PC to act as an X Window server under DOS.

CHARACTER FLAWS

User interfaces that incorporate graphics images have an undeniable visual appeal, but most computers cannot display bit-mapped graphics. More memory and processor resources are required to manage a graphics display. In the Unix market, many users are connected to character-oriented terminals through relatively low-speed serial links. High-speed graphics terminal connections, such as the fiber-optic-link terminals from SunRiver, are two to three times more expensive than character terminals.

In the PC market, many existing monochrome and CGA systems do not have sufficient graphics abilities. Consequently, both Unix and OS/2 support character-based applications but do not provide a consistent character-based user interface.

A typical multiuser Unix system may be connected to many terminals, each with its own escape sequences for cursor positioning, video attributes, and editing functions. Many Unix utilities use teletype-style I/O that avoids windowing on a terminal. Nonetheless, windowing has become an essential part of user interfaces in Unix, and applications must exploit terminal-dependent features. To simplify development, Unix System V provides *curses*, a window programming library for character terminals. Its major goal is to afford device independence, not to provide a consistent user interface. Because curses does not enforce or encourage standard interaction with the user, two applications that use curses may look and behave differently.

Curses provides developers with more than 170 functions and macros to design character-based windows on various terminals. Multiple windows may be placed on a terminal screen and I/O switched among them under program control. Output routines in curses take advantage of data already on the screen that do not need to be replaced.

This optimization provides good performance on low-speed serial links, such as modem connections with remote terminals. Curses functions can build logical windows called *pads*,

which are larger than the display device, and then display and move selected portions of the pad into the display-device window. The curses library permits drawing boxes using character graphics, but does not support vector or bit-mapped graphics nor pointing devices such as a mouse.

In November 1988, the Santa Cruz Operation (SCO) announced Office Portfolio, a character-based user environment layered over Unix. Office Portfolio applications share a common user interface and can exchange data through a clipboard. SCO is offering its own set of applications that run under Office Portfolio, including word processing, spreadsheet, SQL-based data management, project planning, presentation graphics, and statistical analysis. The central application in Office Portfolio is the SCO Manager; it provides electronic mail, an appointment calendar, file management, and a menu system for selecting other applications. An SCO toolkit integrates third-party and end-user applications.

OS/2 facilities for character-based display programming include simple teletype-style I/O using DosWrite and DosRead functions, and direct display output using OS/2 Vio functions, which do not provide the window-formatting capabilities of Unix curses, but which do include more powerful font and cursor-manipulation commands and screen-color control.

In the OS/2 environment, processes run in screen groups, or *sessions*. The operating system's session manager allocates each screen group its own virtual display, keyboard, and mouse devices. The video output of only one session at a time may be present on the physical display device. Other screen groups execute in the background, and their video output is sent to their own virtual display. When a user selects a screen group, its virtual display buffer is copied to the physical display buffer and it becomes visible. Unix provides a similar facility, called *virtual terminals* or *multiscreens*, so that a single display and keyboard can switch among multiple sessions. A single user can log into multiple sessions with different user names.

ONWARD TO GRAPHICS

To support a GUI, both Unix and OS/2 must interface to graphics hardware that allows device independence for applications. Most DOS applications are examples of device dependence in that they write directly to video memory and I/O locations and handle only a few types of graphics hardware (Hercules, CGA, EGA, and VGA). This practice forces designers of new video hardware to duplicate the behavior of old video standards (including bugs) to work with old applications. In contrast, a device-independent application can move from the VGA's 640-by-480-pixel, 16-color mode to a graphics coprocessor with 1,280-by-800-pixel, 4,096-color mode without changing. It looks better and runs faster in the second environment but works in either.

The operating system kernels in both Unix and OS/2 do not provide complete device independence for graphics applications. That job is left to the GUIs layered above the operating systems. The programmer writes to the GUI's API and is therefore shielded from device-dependent details. This sharing of duties leads to two levels of device drivers for a device: one in the operating system, handling only low-level access to the device, and another in the GUI, mapping operations in virtual display space to the device's physical characteristics.

The operating system kernels in both Unix and OS/2 do not provide complete device independence for graphics applications.

Unix typically preserves its terminal-interface architecture when driving high-resolution graphics terminals. These are usually vector graphics machines except for high-end graphics workstations using Unix on proprietary platforms that provide bit-mapped graphics coprocessors. One interfacing approach is to provide graphics memory access through a Unix device driver and use the standard **read**, **write**, and **ioctl** services to communicate with the driver. Graphics support is not standard with Unix but is a value-added feature of vendors such as Apollo Computer and Sun Microsystems.

In OS/2, operating system Vio services allow graphics applications to be developed, but Vio does not directly support graphics. In screen groups that use only character I/O, Vio services retain the contents of text pages and the appropriate palette and other display state information for the video board. To support graphics, applications provide a thread that Vio can awaken for graphics save or redraw. Presentation Manager uses this feature to receive notification of switches into or out of a Presentation Manager session.

Two methods exist for obtaining an X Window environment for a Unix platform. The first is to purchase it from a Unix vendor. DEC's DECwindows is one choice and Interactive Systems Corporation sells a version of X Window that is compatible with its version of AT&T Unix System V for 80386-based PC platforms. Sun provides NeWS/X11, a package combining X Window and Sun's own networked graphics package, NeWS. IBM also provides an X Window package with AIX on the RT PC.

Because X Window comes in two parts—the client and server/device interfaces—those purchasing X Window for a host machine may need to shop for workstation/server combinations that will operate on their network. For basic development purposes, however, a local server often comes with the X Window package to display X Window graphics data on the same platform on which client applications are running without going across a network.

Another approach for adding X Window to Unix is to purchase the X Window source code from MIT—the source from which all vendors generate their X Window packages. MIT provides source code at the cost of documentation and media. This approach allows the user to port or configure the source more closely to a specific hardware platform for which a released version is not available from a vendor. MIT provides source code for four components: the X Client Library, the X Window Manager, the X Toolkit, and sample code for an X Server.

If your Unix vendor does not make all pieces of X Window available in source form, developers can purchase MIT source code in addition. This is important for building new widgets or modifying the window manager. Meddling with client library or server code is unwise because these constitute the heart of the standard.

No third-party applications for OS/2's Presentation Manager were available at press time. The Presentation Manager runtime environment is bundled with the retail version of OS/2; the Software Development Kit (SDK), available separately from Microsoft, contains the C-language API header files and resource-management tools for building applications.

In contrast to the low-cost source-code distribution of X Window, Presentation Manager is tightly controlled by codevelopers Microsoft and IBM. Source code for Presentation Manager is not available, but this might not be a problem for application developers. Presentation Manager is a more complete environment than X Window and has many methods for applications to modify built-in functionality.

One of the major reasons X Window is supplied in the form of source code is that it must be ported to Unix on different hardware architectures. Porting usually requires modifying code and recompiling it for the target machine. If Presentation Manager/X (the HP-Microsoft port of Presentation Manager to Unix) becomes popular, however, other vendors will need source code to port Presentation Manager to other Unix environments.

DISTINCT VIEWS, SAME GOALS

The fundamental components of X Window are a client programming interface that resides on the host, a server on the workstation, and a protocol by which the client and the server interact. This approach permits multiple clients to request services from a common network resource.

The definitions of client and server are reversed from their traditional roles in the PC-based world. In X Window, the server is the workstation or PC that houses the display hardware and interacts with the user; it provides display-management services to processes on other computers (its clients) in the network. In essence, the server acts as an intelligent graphics terminal. Most application code resides on the client machine, physically removed from the user's workstation. A protocol transfers client information over the network to the server and returns responses to client processes. The server transmits user action by passing events to the client; the client processes the events and relays responses to the server for display.

Unlike X Window, Presentation Manager is not structured with the client-server paradigm. Even though Presentation Manager provides workstation display-management services to different OS/2 client applications, it must interface with only one display device, one keyboard, and one mouse. Unix systems often must be able to interface with many terminals, displays, keyboards, and pointer devices. The problem of interfacing graphics applications differs from OS/2, where all physical components reside on the bus of the host machine.

TABLE 1: ***Event Messages***

INPUT EVENTS
Key was pressed/released
Mouse entered/left the window
Mouse moved
Mouse button was pressed/released
Input focus window changed
WINDOW EVENTS
Window visibility has changed
Window has been created/destroyed
Parent window size has changed
Window requires repainting
Window resize request
Window position has changed
Color map has changed

Some event messages are comparable in both X Window and Presentation Manager. X Window has 30 basic messages, whereas Presentation Manager provides more than 150 messages that incorporate support for dialog-box controls and menu selection.

The application programming models of both X Window and Presentation Manager are event-driven and share some events (see table 1). Events are messages initiated by the keyboard or the mouse, but are also generated by programs. They are the primary means of communications among applications, the user, and the presentation subsystem, and they allow clients to communicate with each other. X Window and Presentation Manager must translate input into events and distribute them, tracking which clients are eligible to receive which events.

Programs in either environment rest in wait loops until the underlying window-management system generates an event as a result of a user action. Figure 1 shows sample code for the main program of an application in both environments. Similarities exist between the systems in window creation actions and the loop that allows the program to wait for and dispatch events to application components.

Differences exist in function and performance. An X Window client program must specify the server to be used with the OpenDisplay function call, the network number, host ID, and terminal/screen ID in the call. Presentation Manager has no analogue.

Window-hierarchy management (ordering windows) is important in the architecture of both systems. Windows are organized as parents and children; a child window is contained completely within the parent window. X Window and Presentation Manager maintain relationships among windows, so attributes may be inherited and the effects of events applied to related members.

Facilities offered by X Window and Presentation Manager for graphics programming differ significantly. Presentation Manager's Graphical Programming Interface (GPI) has more than 200 functions (see "A Consistent API," Michael Brian Bentley, March 1988, p. 78), compared with 55 functions for graphics programming in X Window. Each includes simple line shape and color management. Presentation Manager, however, has more complex graphics-management functions, including multilayer coordinate spaces and coordinate transformations, stored graphics output in bit-mapped and meta-language files, and bit-mapped transformations. X Window is designed to be interfaced with existing Unix graphics libraries.

Presentation Manager's device-independent GPI accommodates many graphics presentation devices, including printers, video displays, plotters, and graphics image files. The device driver and support logic in Presentation Manager transform device-independent graphics requests to specific control commands for the device. Presentation Manager also can provide device-specific information to an application to set strategies for presenting data. Presentation Manager applications can affect their own windows, but may not affect intrinsic device characteristics and therefore cannot inadvertently affect other applications. Because Presentation Manager insulates applications from device details, applications need not test for changes due to alteration of basic device parameters.

X Window recognizes only one type of device—bit-mapped displays. X Window clients interface only to a server, but have flexibility in responding to differences in bit-mapped displays and server conditions. Client applications provide the server with *hints* about how they want their windows displayed (for example, size of a window, the device color map, or the priority given to placement of a window). The server's window manager may adjust hints to suit the needs of all applications presented on the server screen. Device limitations and existing states of the server based on usage by other applications limit the degree to which the server can accommodate requests contained in hints.

When device changes (such as a change in the color map) occur in a

FIGURE 1: *Event-driven Programming Model*

X WINDOW CODE EXAMPLE

```
#include <X/Xlib.h>
#include <stdio.h>

main ()
{
     Window w;      /* window handle of our example program */
     XEvent *ev;    /* event message structure */

     /* Open the default display */
     if ( XOpenDisplay ( "" ) == NULL )
     {
          fprintf ( stderr, "Could not open Display\n" );
     }

     /* Create the demo window */
     w = XCreateWindow (
               RootWindow,    /* use root window as the parent */
               10, 10         /* x and y window origin */
               200, 200       /* window width and height */
               BlackPixmap    /* border */
               WhitePixmap ); /* background */

     /* Tell the server to display the window */
     XMapWindow ( w );

     /*  Wait for an event:
      *
      *  In the normal X application, this loop continues
      *  indefinitely. Events are passed on to the appropriate
      *  event manager, in this example via the user-supplied
      *  process_event function.  The system or the event
      *  manager terminate the event loop based on a user or
      *  system request.
      */
     for ( ;; )
     {
          XNextEvent ( &ev );
          /* user function for disseminating events */
          process_event( &ev );
     }

     /*
      *Kill the window and flush the output queue.
      *This code normally appears in an event processing
      *routine, but is shown here for comparison with PM.
      */
     XDestroyWindow ( w );
     XFlush ( );
     exit ( 0 );
}
```

PRESENTATION MANAGER CODE EXAMPLE

```
#include <os2.h>

main ()
{
     HAB  hAB;            /* anchor block handle */
     HMQ  hMQ;            /* message queue handle */
     HWND hWndFrame;      /* standard window handle */
     QMSG qmsg;           /* message queue message structure */

     /* Obtain an anchor block handle from PM */
     hAB = WinInitialize ( );

     /* Create a message queue for events */
     hMQ = Wincreatemsgqueue ( hAB, 0 );

     /* Create a standard window for demonstration purposes */
     hWndFrame = WinCreateStdWindow (
               HWND_DESKTOP,       /* parent window */
               WS_VISIBLE |        /* window style flags */
               FS_SIZEBORDER |
               FS_TITLEBAR |
               FS_SYSMENU |
               FS_MINMAX ,
               NULL,               /* no client win class name */
               "OS/2 PM DEMO"      /* title of window */
               0L,                 /* client window style */
               NULL,               /* resource module handle */
               0,                  /* resource ID */
               NULL );             /* client window handle ptr */

     /*
      * Enter the message processing loop. Messages will be
      * dispatched to the appropriate window procedure until
      * the user or the system requests termination.
      */
     while ( WinGetMsg ( hAB, &qmsg, NULL, 0, 0 ) )
     {
          WinDispatchMsg ( hAB, &qmsg );
     }
     /*
      * WinGetMsg returns a 0, and the loop terminates, because
      * the user elected to kill the window through the system
      * menu.  First destroy the window, then destroy the message
      * queue, and lastly tell the PM that we are leaving.
      */
     WinDestroyWindow ( hWndFrame );
     WinDestroyMsgQueue ( hMQ );
     WinTerminate ( hAB );
     return ( 0 );
}
```

Both X Window and Presentation Manager use an event-driven processing model. The main program first executes a loop that waits for an event to arrive from the environment, then dispatches that event to the appropriate handler.

server, the server sends an event to all applications so that they correspondingly can adjust their requirements or mode of operation. This potential for changes in the server's device state increases complexity and uncertainty in the X Window environment.

Presentation Manager gives applications a *presentation space* (PS) for drawing text and graphics. The PS is independent of windows on the video display and other output devices with which the application may interface. To produce output from the PS, the application must map it to a device such as the video display or a plotter. This scheme enables the system to produce output from a device-independent set of display objects whose units may be converted to device-relative units (the pixel or point dimensions of the output device) at the time of display. Similarly, X Window provides a *graphics context* (GC) that includes information on drawing elements, such as foreground and background pixel colors, line-drawing width, and clipping regions.

X Window's GC and Presentation Manager's PS can reduce information associated with each graphics function call. Many pieces of information are needed to perform a graphics operation on a device. If all information had to be provided with each graphics function call, the parameter list would be so huge that operations would take an inordinate amount of time. To reduce this overhead, the window manager in both systems retains the standard set of information (modes) to determine the specifics of each graphics operation. Other calls are available to change modes.

Although their concepts are similar, GC does not contain the wealth of information nor provide the flexibility of PS. An X Window GC provides two important benefits, both related to performance: it reduces traffic between an application and the server when drawing requests are made, and it allows

TABLE 2: *Resource-building Facilities*

	X WINDOW SYSTEM	PRESENTATION MANAGER
Resource definition language	●	●
Resource compiler	●	●
Window definition	○	●
Menu definition	●	●
Dialog and form definition	●	●
Radio buttons	○	●
Check boxes	○	●
Push buttons	●	●
Group boxes	●	●
Static (view only) text	●	●
Text input fields	●	●
List boxes	○	●
Keyboard accelerators	●	●
Font editor	○	●
Icon editor	○	●

● = *Yes* ○ = *No*

Presentation Manager has more tools for building and editing resources than does X Window. Developers must create most X Window resources by writing C code.

servers to maintain multiple GCs, permitting applications to switch easily to make broad changes in graphics appearance in a window. For example, different GCs can contain different color designations and pen widths, providing almost immediate changes in the look of an application by switching to another GC. X Window, however, does not map the GC to devices other than the bit-mapped display.

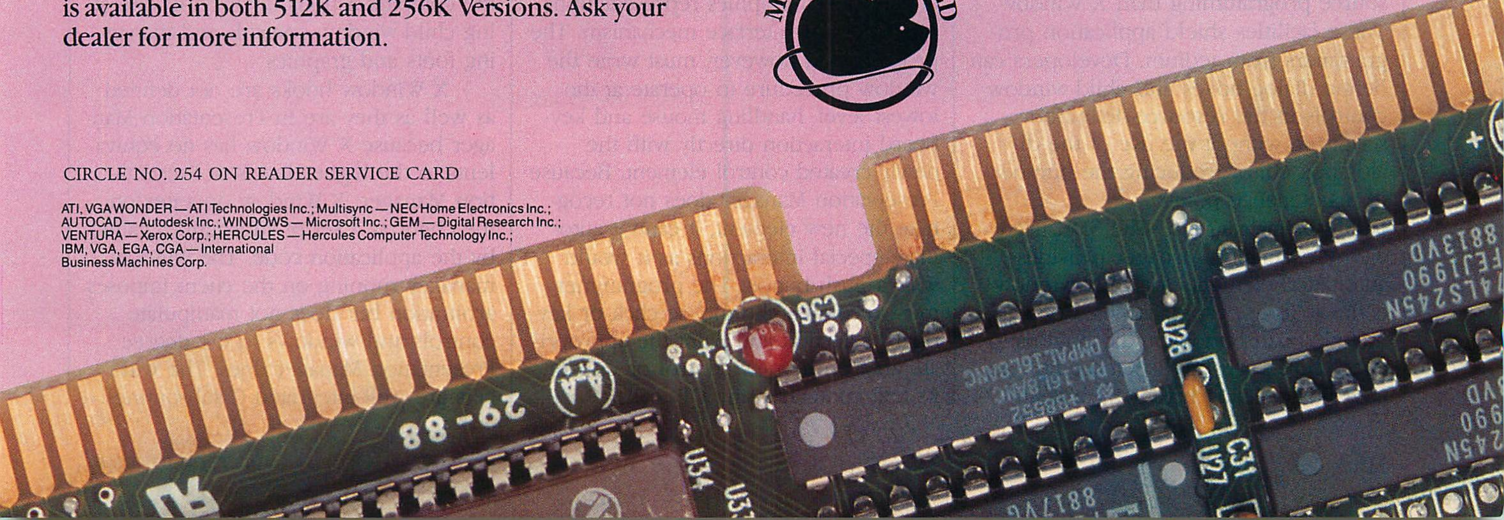
DRAWING ON RESOURCES

A GUI must maintain an efficient internal database of *resources*, including window definitions, fonts, bit maps, icons, and graphics context data. Because these objects create and redraw graphics images, users require rapid access to them. If font data, often stored as pixel-by-pixel representations of characters of different typefaces, cannot be accessed at blinding speed, then simple display of text on a graphics device flounders.

A vital ingredient to the usability of a GUI environment is the ease with which developers can create and manipulate resources. Table 2 summarizes the functions that X Window and Presentation Manager provide for building and maintaining resources. The facilities of X Window are more elemental than those of Presentation Manager, but X Window developers have a rich set of services upon which to build.

Significant differences exist in the ways X Window and Presentation Manager integrate resources with an application. Presentation Manager requires an application's resources to *be bound* with the application's executable image. Presentation Manager precompiles icon bit-mapped files, menu and dialog box definitions, and string constants with a resource compiler, and then links into the application executable file. Resources, including device drivers, can also be obtained from dynamic link library (DLL) modules. Presentation Manager maintains system-dependent resources, such as printer types and available fonts, in a separate initialization file. Resources, such as icons, menus, and dialog boxes, are automatically accessed by Presentation Manager at runtime. Applications can also access resources via functions in the API.

The X Window database manager, called *resource manager*, manages property and resource information (such as bit maps and widgets) for applications. X Window resource management is split between the needs of the server and the client. Users can access client resources stored on the client machine only through the client code. Resources at the server are called window *properties* (such as window size and color). A property identifier, consisting of a name, type, data format, and data, refers to the property. The property data format denotes whether the data have 8-, 16-, or 32-bit elements



and helps the server correctly read and write data. For example, the client application can execute on a 68030-based machine with a 32-bit word while the server executes on an 80286-based machine with a 16-bit word whose bytes are ordered differently.

The resource manager allows X Window applications to be customized at runtime in a similar way as the Presentation Manager control panel and initialization profile. The resource manager provides more flexibility than the Presentation Manager control panel, because the former can perform translation bindings between key sequences and resulting functions via text strings accessed at runtime. X Window resources can come from one of four places: resource properties of the root window, application-specific resource disk files, an initialization file of user defaults, or the command line of an X Window application.

An X Window application can be reduced to the two traditional maintenance points of the C language—program source and the include files. The X Toolkit provides primitive equivalents to Presentation Manager's dialog box controls and other resource-definition language elements. X Window, however, has no bit map, font, or icon editing tools like the ones in Presentation Manager. This leaves the application developer with a lot of unfinished business to attend to before getting on with development. Building resources such as icons can be tedious for a developer if they must be built in program source code, and such practices make applications inflexible; simple changes to an icon require program recompilation. Although robust, the X Window resource-management scheme is low level in function compared with Presentation Manager. Higher-level toolkits, such as Open Look, may help to resolve this deficiency.

Presentation Manager has more complete high-level facilities for resource programming than X Window. These facilities shield application programmers from tedium. Developers can define dialog boxes and child-window controls in the resource-definition script file without the use of the dialog-box editor, reducing the number of maintenance points.

Child-window controls. The SDK used with Presentation Manager provides automated elements for child-window controls in user applications. Controls include push buttons; radio buttons; check boxes; group, list, and edit boxes; and dialog boxes. Each is an automated window element, with much of its operation handled for the application by Presentation Manager. Highlighting selected buttons, marking check boxes, inserting or deleting text in edit and list boxes, and even mutual exclusion in the operation of radio buttons are automatic. Presentation Manager removes the burden of performing these detailed operations.

Developers can create child-window controls using the dialog box editor or scripts in the application's resource script file. Using API functions at runtime creates child-window controls. Adjusting size, shape, control type, text contents, and location is done during creation. Messages provide bidirectional communications between child windows and the parent window. With the child-window controls, users can generate messages, including child ID, text entered by the user, button selection, and button receiving focus (by mouse click or by selection via the Tab key). The program also can send messages to the child window to act on controls—for example, by inserting or selecting text, and pressing a button or checking off a check box.

As with the decision between Unix and OS/2, the choice of GUIs ultimately depends on the market for the application.

Finally, developers can use child windows to construct special controls that communicate with the parent just as the automated child-window controls do. The full set of graphics elements, including lines, circles, arcs, chords, rectangles, colors, and bit maps, can create special graphics representations of almost any interface mechanism. The programmer, however, must write the window procedure to operate at the lowest level, handling mouse and keyboard interaction directly with the newly created control element. Because Presentation Manager does not recognize the new element, it cannot automate special interactions as it would with a push button. The programmer must recognize the mouse click or keyboard selection and paint the appropriate area of the new control or update its text contents using GPI calls.

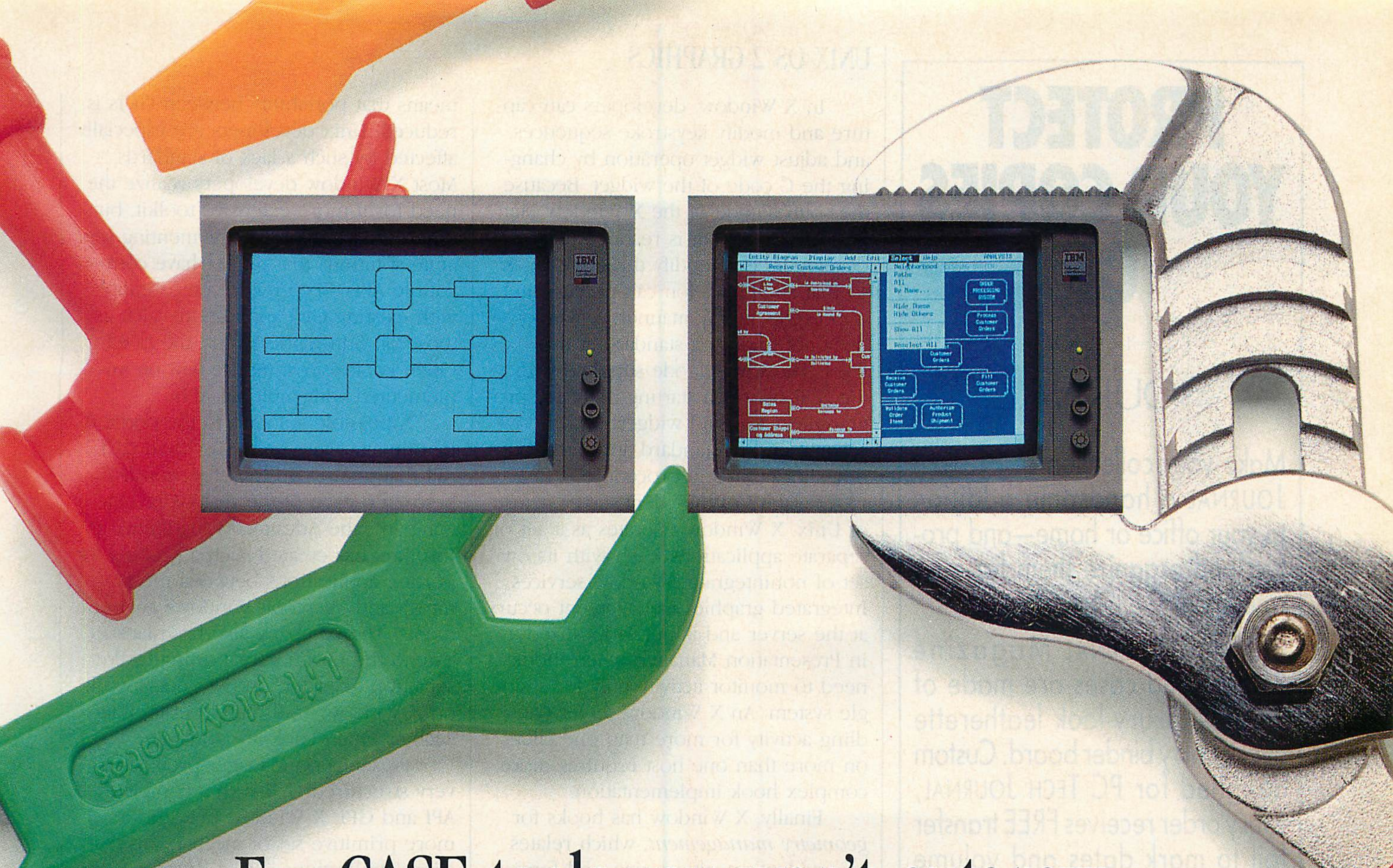
X Window does not provide the abundant built-in controls that Presentation Manager does. The X Toolkit creates a minimal set of widgets from low-level components, includes source code and documentation for several widgets, and provides sample programs. It allows developers to create or destroy widgets and monitor or set data values. Toolkits from other vendors have more complete controls, such as the X user interface (XUI) in the DECwindows package. Because widgets in X Window are a window, possibly combining other widgets, they have a window ID. (Windows in Presentation Manager also have IDs.)

For complex applications where toolkit facilities are not sufficient, developers need the ability to customize without sacrificing or violating any standard. The developer may want to modify the behavior of an already constructed control element or incorporate a new set of custom tools or extensions into the system.

Application hooks. Presentation Manager has a solid scheme for an application to *hook*, which means to modify or enhance the system's default behavior. At the system level, an application can monitor and modify keyboard and mouse activity before passing it to the default Presentation Manager handler; at the tool level, it monitors and modifies this activity for specific child-window controls.

Two types of chains may be hooked: the *system chain* permits installing hooks that can affect all application processes executing in Presentation Manager, while the *queue chain* affects only threads running within a process. To accommodate memory-management constraints among processes, Presentation Manager allows installing hooks in the system chain from modules in DLLs because these modules may be shared among processes. Local hooks in the queue chain may be a thread within a process. Hooks adjust the complex actions involved in operating child-window controls and managing fonts and graphics.

X Window hooks are not defined as well as they are in Presentation Manager because X Window has no equivalents to the higher levels of Presentation Manager. X Window operates on the client as a set of subroutines called by the application code. The window manager running on the client imposes arbitration but does not manipulate controls and windows to the degree Presentation Manager does. The widgets are well-integrated C subroutines.



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In X Window, developers can capture and modify keystroke sequences, and adjust widget operation by changing the C code of the widget. Because the source code of the X Window Manager and X Toolkit is readily available, developers can modify these packages so that an application can process and trap events in any manner. X Window does not impose a standard at this level. The widget code supplied with the X Toolkit is a starting point for programmers to build widgets. X Window recommends a standard approach, but does not enforce a procedure.

Because of the client-server nature of Unix, X Window operates as a set of separate applications, each with its own set of nonintegrated window services. Integrated graphics management occurs at the server and is not as localized as in Presentation Manager, where hooks need to monitor activity only for a single system. An X Window server handling activity for more than one client on more than one host requires more complex hook implementation.

Finally, X Window has hooks for *geometry management*, which relates to a widget's position, size, and format on the video display. If a window contains a set of push buttons aligned horizontally by default and the user wants to change the shape of the window to a vertical alignment, a geometry manager can determine optimum vertical alignment. The user could keep the buttons visible while selecting an optimum layout that considers other windows. The designers of Presentation Manager eschew geometry manager hooks in favor of GUI consistency among applications. Such consistency may be imposed on X Window once OSF selects a windowing standard.

PLOTTING A COURSE

With the certainty of GUIs in future systems and applications, developers will be challenged to master these new environments to meet the needs of end users. As with any young technology, hardships await those pioneers who hope to stake a claim. The GUI programming paradigm employs an event-driven model rarely found in current character-based applications. Most rules that an application uses for interacting with the system must change. Although the GUI insulates developers (and their applications) from many concerns, it still requires them to understand new concepts and practices.

Another sign of the immaturity of GUIs is the lack of standards. To a developer, the lack of a standard API means that portability between GUIs is reduced. Unix developers are especially affected by such a lack of standards. Most X Window developers realize the need for a more extensive toolkit, but different factions are implementing separate solutions that do not have compatible APIs. To provide compatibility with existing GUI applications such as those on Sun workstations, the AT&T Open Look user interface will be implemented with multiple APIs.

A possible solution to the portability dilemma is to create a virtual GUI API that is mapped by a function library into each of the real GUIs. One company, the Advanced Programming Institute, has created such a product for porting applications between the Macintosh and Microsoft Windows environments. The company also has plans to extend the product for porting to Presentation Manager, but will delay work on X Window until high-level toolkits such as Open Look are available.

Presentation Manager provides a very structured GUI with a complete API and GPI; X Window provides a more primitive set of mechanisms that client applications use to distribute data to windows on different workstations in a network. While Presentation Manager is a complete environment for windowed user interfaces, X Window is more of a tool. Finally, only Microsoft implements Presentation Manager, whereas many vendors have extended X Window in different ways, pointing once again to the lack of a single GUI standard in the Unix community.

A developer looking for a GUI environment is faced with a dilemma. Presentation Manager provides better tools for development and offers a consistent user interface, but is built upon an operating system that has yet to prove itself. X Window is a more skeletal development environment, but is built upon the well-entrenched and thoroughly tested Unix operating system; soon-to-be-released toolkits may improve its functionality.

As with the decision between Unix and OS/2 , the choice of GUIs ultimately depends on the market for the application. Developers who currently want to have application portability between the Unix and OS/2 graphics environments will find the job difficult, but not impossible.

Robert R. Morris and William E. Brooks are among the founders of Applied System Technologies Inc. of Ft. Lauderdale, Florida. Their previous collaboration in PC Tech Journal *was the December 1988 cover suite.*

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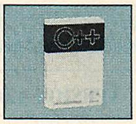
PRODUCT WATCH

Reviews and Updates

TURBO PASCAL 5.0
Borland International



ZORTECH C++ 1.02
Zortech Inc.

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UPDATE

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408/438-8400

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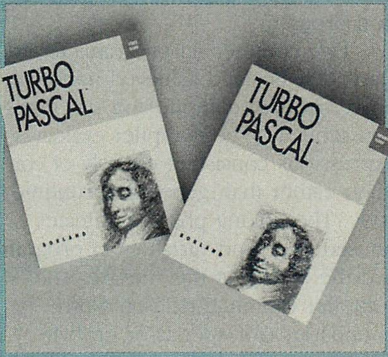
$250, Professional version



CIRCLE 339 ON READER SERVICE CARD

Debugging Turbo Pascal programs has never been an easy chore. In the past, Borland did not offer a source-level debugger, forcing developers to turn to third-party debuggers, such as TurboPower Software's TDebug or utilities that convert compiler output to a format acceptable to other symbolic debuggers.

With Turbo Pascal 5.0, however, Borland now offers not one, but two solutions. The Turbo Pascal integrated development environment features source-level debugging; for large programs and more sophisticated debugging, Turbo Pascal Professional adds the stand-alone Turbo Debugger and Turbo Assembler. (See "Turbo Debugging," Ben Myers, January 1989, p. 46 and "Thoroughly Modern Turbo," Ben Myers, April 1988, p. 122.)

The Turbo Pascal integrated debugger is designed to debug Pascal source code only. It can set breakpoints on source lines, watched variables, arrays, or structures, and can evaluate expressions and trace single source-level statements. Two statement traces are possible—trace and step over. Trace executes the next source statement, whether or not a procedure or function call is run. The step-over function executes a procedure as though it were a single statement. It does not enter the called function, but executes it and stops at the source-code statement beyond the call.

Setting watchpoint expressions illustrates the convenience of the integrated environment. The package displays a watched variable in a format appropriate to its type, displays elements of watched structures and arrays in a suitable format, and shows enumerated data types using the named values from the source code. The debugger also evaluates expressions and permits the user to change variables (again using the appropriate data format) or inspect calls at the source-code level by viewing the call stack.

Improved debugging is not all that version 5.0 provides. It offers an assortment of additional functions, procedures, and features designed to make programming easier. These include support for program overlays and floating-point operations, an expanded runtime library, several new utility programs, and additional graphics support.

Turbo Pascal program overlays (included in version 3.0, but not in 4.0) have returned in 5.0. The overlay-manager procedures are different and more flexible than those in 3.0. Overlays reduce the amount of memory needed for executable code, but are not a mechanism to overcome the 64KB data-segment limit.

Global variables within an overlay unit are part of the same data segment as global variables in the calling program. The overlay manager can copy all overlays into expanded memory and swap them as needed. Overlays are compiled as units containing the $O+ (overlays allowed) and $F+ (far calls) directives and then linked with a calling program that defines them as overlays using $O *unitname*.

Version 5.0 also supports emulated floating-point operations, so the same .EXE file can run on a PC with or without 80*x*87 math coprocessors. When a user starts the program, the runtime library detects if a math coprocessor is installed and adjusts itself accordingly. To emulate floating-point operations, the user must compile the program with the $N+ (use hardware floating point format) and $E+ (link floating-point emulator routines) directives. *PC Tech Journal*'s test of floating-point operations, ACCURACY (see Measuring Numerical Accuracy," Jim Roberts, January 1988, p. 142), shows that emulation does not diminish arithmetic precision. Both the hardware and emulation achieved an excellent error rating of 0.02 for the extended floating-point type. ACCURACY is available on PCTECHline.

Borland expanded the runtime library with 31 new functions and procedures to simplify programming and reduce dependence on third-party runtime libraries. In addition to the procedures in the overlay manager, other functions permit easy access to DOS calls and provide file and directory searching capabilities.

Borland also added three new utilities: TINSTXFR, THELP, and BINOBJ. For Turbo Pascal 4.0 users, TINSTXFR helps reduce the amount of time and effort required to convert to the new version by copying version 4.0 compiler defaults to version 5.0. THELP is a terminate-and-stay-resident (TSR) help utility that assists users of the batch compiler. THELP occupies 8KB of RAM and cannot be removed from memory without rebooting. BINOBJ converts any binary file to .OBJ format. Once

TABLE 1: ***Turbo Pascal Performance***

PROGRAM	NUMBER OF SOURCE LINES	VERSION 4.0 COMPILE	VERSION 4.0 RUN	VERSION 5.0 COMPILE	VERSION 5.0 RUN
1	608	6.4	—[a]	5.6	—[a]
2	628	4.1	—[a]	4.0	—[a]
3	2,079	10.8	4.8	10.6	4.6
4	3,254	14.1	32.1	13.1	31.6
5	6,652	25.2	87.9	24.3	84.6

All times are in seconds.
Tests were run under DOS 3.3 on an 8-MHz PC Designs Turbo AT with a Seagate 40-ms ST-251 hard disk.
[a] Programs 1 and 2 are too small to time reliably.

Despite extra baggage from many additions, version 5.0 does not backslide in compile or runtime performance.

TABLE 2: ***Turbo Pascal Program Sizes***

PROGRAM	VERSION 4.0 PROCEDURE	VERSION 4.0 DATA	VERSION 5.0 PROCEDURE	VERSION 5.0 DATA
1	20,448	1,959	20,192	1,856
2	19,600	4,195	19,248	3,242
3	27,824	56,103	27,216	54,508
4	44,032	35,095	45,424	34,244
5	50,672	62,839	50,240	60,384

All sizes are in bytes.
Tests were run under DOS 3.3 on an 8-MHz PC Designs Turbo AT with a Seagate 40-ms ST-251 hard disk.

New features also did not affect program size significantly. Most of the test programs actually decreased slightly in size.

converted, information can be linked into an .EXE file rather than remaining as a freestanding file.

The Borland Graphics Interface (BGI) library now supports the IBM PS/2 8514/A high-resolution graphics adapter, although the BGI does not detect its presence automatically. This limits the 8514 to applications that request its configuration at installation time or assume that it is always present. The BGI supports the 8514 high-resolution mode (1,024-by-768 pixels) with 16 colors, a lower resolution (640-by-480 pixels) with 256 colors, and has new graphics procedures to fill ellipses, manage palettes, and install user drivers and stroke fonts.

Aside from these new features, incorporating a debugger into the Turbo package required Borland to make several changes that Turbo Pascal users will notice immediately. The first is more serious than the second.

The integrated environment has grown in size (from 211KB in version 4.0 to 242KB in version 5.0). Because it does not use overlays, however, the effective size of programs that can be run or debugged within the integrated environment is reduced.

Of the two, debugging is the more serious limitation. When the small OVRDEMO.PAS program on the Turbo Pascal demonstration diskette was compiled with internal debugging tables, it occupied more than 88KB. The integrated debugger did not have enough memory to run a sample program that uses less than 140KB including its stack (16KB) and heap (8KB).

The second change, although inconvenient, is not serious. In earlier versions, the F7 key defined the beginning of a block of text and the F8 key ended the block. In version 5.0, the F7 and F8 keys control some debugging functions. Only the WordStar commands Ctrl-K-B and Ctrl-K-K begin and end blocks. The user can define additional function keys with the installation program.

Five commercial programs tested show that Borland achieved minor improvements in compile and run times (see table 1). The compiler evaluates expressions consisting entirely of constants rather than generating runtime code. The linking phase eliminates unused code and variables in programs and the units that they invoke. The compiler can align data on word boundaries (for speed) or on byte boundaries (for a more compact program). The compilation speed of 16,300 lines per minute for program 1

is commendable, considering that it included linkages to many procedures and functions contained in units.

Table 2 shows the difference in .EXE file size between versions 4.0 and 5.0 for applications that have 3 to 26 include files. Each program uses several third-party units in addition to the standard DOS and CRT units. Constants containing software copyright notices were unreferenced by any procedural statements, so they also were removed from the final .EXE files by the intelligent linking process.

For users of previous versions of Turbo Pascal, Borland's upgrade policy is economical: $49.95 to upgrade to version 5.0, $99.95 to upgrade to Turbo Pascal Professional. Version 5.0 adds an excellent debugging capability and includes a collection of useful new features. Turbo Pascal Professional is a bargain for Pascal programmers who also write in assembly language and need the powerful Turbo Debugger.

—BEN MYERS

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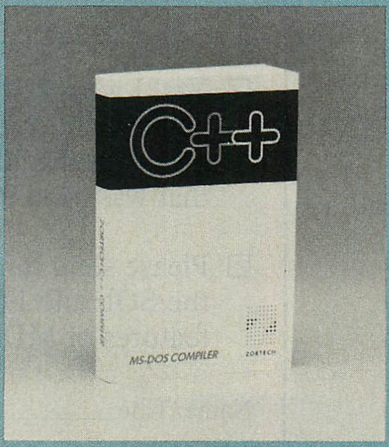

CIRCLE 340 ON READER SERVICE CARD

Many developers have praised C++ as a better C language because it is in tune with the realities of today's large programming projects and complex operating environments. The C++ language has features such as function prototyping, polymorphism, and encapsulation, all of which make large software systems easier to develop and maintain (see "Succeeding C," Marty Franz, September 1987, p. 166).

Despite its many advantages, the language has a major flaw: implemented as a preprocessor, C++ is painfully slow at compiling and linking programs. An additional aggravation is that the source code is not directly usable by debuggers such as Microsoft's CodeView. For developers accustomed to Microsoft's QuickC and Borland's Turbo C interactive coding and debugging environments, C++ may seem to be an unacceptable compromise.

Developers at Zortech took careful note of this situation. The company's new compiler, Zortech C++ version 1.02, features direct, speedy compilation and integrated editing. While still suffering from a few minor flaws, the Zortech C++ compiler is amazingly complete and may be what C++ needs to succeed in the PC marketplace (just as Borland's Turbo Pascal made the Pascal language a viable commercial product for the PC).

THREE IN ONE

The Zortech C++ compiler is actually three compilers in one: a C++ version (compatible with the de facto AT&T standard for the language), an ANSI-compatible C compiler, and an industrial-strength version of the C compiler with more space reserved for its symbol tables. The latter is useful for compiling enormous programs.

In daily operation, Zortech C++ is similar to other C language and C++ compilers—a compiler and a linker generate finished programs. The full-screen Zortech Editor (ZED) is comparable to other editors and has a Lotus-style, moving-bar command interface (activated by pressing the Esc key). When editing text, the WordStar command keys perform the same functions as MicroPro's WordStar and Borland's Turbo C integrated editors do: Ctrl-Y deletes a line while Ctrl-Q-R moves to the top of the file. When the command bar is activated, the arrow keys or single-letter abbreviations (such as F for File or E for Edit) move the bar from command to command.

ZED is fast and convenient. Programmers can invoke the compiler and linker directly from any one of the editor's five separate text buffers and can record frequent sets of keystrokes as macros—a nice amenity. The only complaint with ZED is that the pull-down windows that appear when a command is selected are too crowded with options. Until a developer becomes familiar with the choices, the menus may be somewhat confusing.

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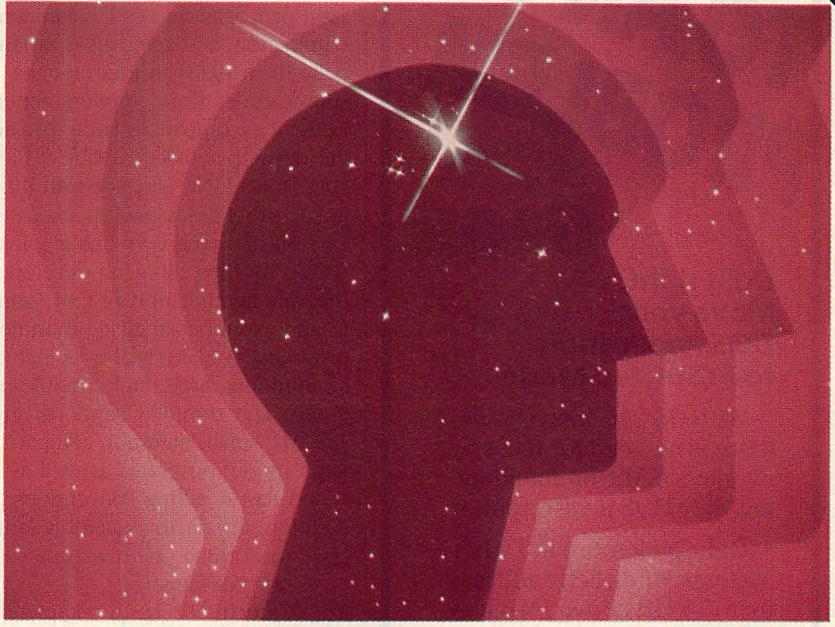

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The extension on the source file being compiled determines whether ZED calls C++ or C. All three compilers feed their intermediate files into a single code-generation program. A global optimizer module performs constant propagation, dead-assignment elimination, and removes invariant code from loops in intermediate source code. The compilers generate CodeView-compatible code, provided the developer links the object files with Microsoft's LINK and not with the linker provided with Zortech C++.

The Zortech C++ linker joins standard .OBJ files, allowing developers to mix any combination of C++, standard C, and assembly-language modules in programs. A Make facility is included for building large, multimodule programs. The compiler supports tiny (.COM), small, medium, compact, and large model programs as well as both C and Pascal calling conventions. In addition, interfacing assembly language code to Zortech object modules should pose no problems.

Zortech C++ has a complete ANSI-standard C library that is compatible with Microsoft C and Turbo C as well as a library of mouse-handling functions and a Flash Graphics library. The graphics functions are written in assembly language and have impressive speeds, but are not as flexible or comprehensive as the Borland Graphics Interface (BGI) drivers. The library supports lines, boxes, text, and shapes on any of the popular PC display adapters, including the VGA.

Mindful of developers who are learning C++ for the first time, Zortech has included a resident, context-sensitive Help facility. Loaded at bootup, it is available by pressing Alt-H, even in DOS or a text editor other than ZED. The Help facility includes text on both C and C++ language statements and library functions.

The Zortech C++ setup and installation program permits the user to select only the parts of the product desired (source code for sample programs may be omitted, for example). Compared with installation programs for other C compilers, Zortech C++ is unusually understandable and smooth. When complete, the product is installed in a ZORTECH directory, with subdirectories labeled BIN, LIB, and INCLUDE (which is a practice followed by other C compilers).

Zortech C++ comes with eight 5.25-inch diskettes and a paperback manual. The manual is organized into three main sections: a user's guide that includes a quick tour of C++ (although a complete primer on the language is wisely recommended several times throughout the documentation), a reference section on the various programs that comprise the product, and a library reference section.

WORTH WAITING FOR

Zortech has done an excellent job in bringing C++ to DOS C programmers. Developers proficient with C compilers should be able to learn to use Zortech C++ without great difficulty. The only disadvantages of Zortech C++ are those of the C++ language itself.

First, although the Zortech C++ compiler has a standard C library, a standard library of *classes* (programmer-defined object types) is not yet defined for C++. Zortech had the perfect opportunity and could have demonstrated the power of C++ by including classes for graphics, windows, mouse handling, and dictionaries. Unfortunately, it did not. Features of the first version of Turbo Pascal that made that language so popular were sensible functions and procedures that made it easier for developers to access the power of the IBM PC.

The second disadvantage is that C++ is still a hybrid object-oriented language—part C and part something new. Many developers may find that using C alone in this convenient format is good enough for their projects. Other object-oriented languages, such as Smalltalk, come with powerful windowing environments that take advantage of object-oriented encapsulation and inheritance.

C++ lacks these capabilities, and Zortech did not extend the language into new territory. Zortech could have included classes for Windows (the most prevalent graphics environment on the PC) to ease the integration of C++ programs into this environment. As it stands now, programmers need to write a number of classes themselves to tap the power of object-oriented programming with C++.

Compared with other C++ compilers that are available for the PC, however, Zortech C++ is an excellent find. It features fast compilation, integrated editing, and on-line help. If you have avoided working in the C++ language in the past because it lacked an integrated environment or was too slow, Zortech C++ may be what you have been waiting for.

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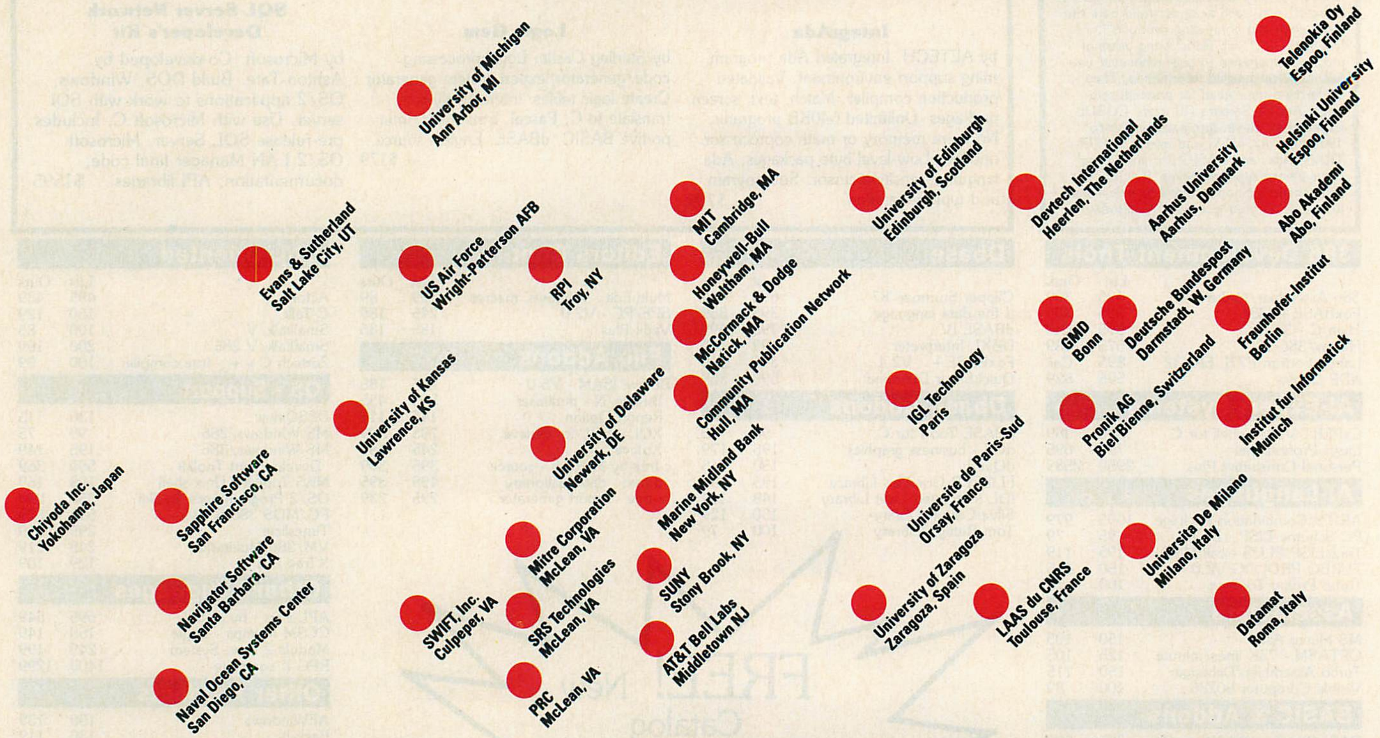

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1 FUNCTION 32H
2 DUAL-BOOT
3 COMPAQ BOOT

Those who divulge undocumented features of DOS usually accompany their revelations with copious caveats about the possibility of such features working differently or not at all in future versions of the operating system. Despite the warnings, programs that depend on undocumented features have proliferated, and many have become so entrenched (for example, Borland's SideKick) that every new DOS version has maintained support for the most widely used undocumented features.

Even OS/2, in its real mode, supports several undocumented functions without which many popular programs would not run in the DOS compatibility box. Before you conclude that warnings about the dangers of using undocumented features are overblown, see the first item for an example of how you can be burned.

September 1988's Tech Notebook (p. 137), which described how to install both OS/2 and DOS in a dual-boot configuration, generated a large reader response. I had hoped that by this time, the manual procedure for installing dual-boot would have become moot as vendors added dual-boot capability to subsequent versions of OS/2. Such is not the case; IBM has since released three versions (Extended Edition version 1.0, Standard Edition version 1.1, and Extended Edition version 1.1), none of which incorporates the dual-boot capability.

The second item in this month's Tech Notebook summarizes the changes IBM has incorporated in the OS/2 installation process and provides updated information for adding the dual-boot capability to these new OS/2 versions and to DOS 4.0.

Finally, many readers reported problems with installing dual-boot into Compaq's version of OS/2. The third item explains the reason for the problems and describes a cure.

1 FUNCTION 32H IN DOS

One very useful undocumented service, used by many disk utilities, is INT 21H, function 32H (get DOS disk parameters). As input, it accepts a drive number in register DX (0 for the default drive, 1 for A:, and so on). It returns a pointer in DS:BX to a data area containing low-level information about the data structure of the specified drive. A companion function, 1FH, takes no input and returns the same information for the default drive.

The structure of the data block returned by these services was previously described in *PC Tech Journal* (see "Finding Disk Parameters," Glenn F. Roberts, May 1986, p. 112) and is repeated here in table 1. That article pointed out some differences between the DOS 2.*x* and 3.*x* versions of this structure (DOS 3.2 was then extant). How has this service fared in subsequent DOS revisions? There is good news and bad news.

The good news is that these functions return the identical information in DOS versions 3.3 and 3.31, and the essential portions of it in all OS/2 versions to date. As noted in table 1, OS/2 does not provide the device driver address pointers and the access flag, but leaves the important disk allocation information unchanged, delivering on the promise to provide the most popular DOS features in the box.

The bad news is that DOS versions 4.0 and 4.01 (hereafter collectively called 4.0*x*) introduce a minor change

TABLE 1: ***DOS Disk Parameter Block***

OFFSET	LENGTH	CONTENTS
00H	byte	Drive number (0=default, 1=A:, and so on)
01H	byte	Logical unit within driver
02H	word	Bytes per sector
04H	byte	Sectors per cluster minus one
05H	byte	Shift count of sectors per cluster
06H	word	Number of reserved boot sectors
08H	byte	Copies of file allocation table (FAT)
09H	word	Maximum root directory entries
0BH	word	First data sector
0DH	word	Highest cluster number (cluster count plus one)
0FH	byte	Sectors per FAT[a]
10H	word	First directory sector
12H	dword	Address of device driver[b]
16H	byte	Media descriptor byte
17H	byte	Access flag (zero, if disk was accessed)[b]
18H	dword	Pointer to next parameter block[b]
1CH	dword	Reserved (usually FFFF:0000)

[a] *Word in DOS 4.0x; all subsequent values move up one byte.*
[b] *Not meaningful in OS/2 real mode.*

Undocumented features of DOS, such as this structure returned by functions 1FH and 32H of INT 21H, are subject to change. DOS 4.0 extends this table by expanding the length of the file allocation table (FAT) from a byte into a word.

that has a major impact on all programs using this information. The length of the value at offset 0FH, which gives the size of the file allocation table (FAT) in sectors, goes from a byte to a word, and all subsequent values move up by one byte. The length of the table increases from 32 to 33 bytes.

The change is ostensibly to support the larger disk partitions (greater than 32MB) possible in DOS 4.0*x*. Large partitions can be implemented, however, with no change to the structure of the parameter block—DOS 3.31 from Compaq and OS/2 1.1 from both IBM and Microsoft do it. Yet, despite the differences in the parameter block format, a large partition created by any version of DOS or OS/2 can be used by any other version.

Partitions larger than 32MB are implemented with the same sector size (512 bytes) and FAT structure used in all DOS versions since 3.0 (see "DOS Marches On," Richard Wilton, January 1989, p. 98). With 16-bit FAT entries, the maximum number of clusters is 65,536; at two bytes per entry, a maximal table occupies 128KB or 256 sectors on disk. In DOS 4.0*x*, IBM changes the structure of the disk parameter block to accommodate the one extra bit in the event that the FAT reaches the maximum size of 100H.

Two alternatives to enlarging the parameter block exist. One is to use a zero value to represent a FAT that is 256 sectors long. Because a DOS disk cannot have a zero-length FAT, there can be no confusion. The other alternative is to double the size of a cluster, thereby halving the size of the FAT when the size of the table would otherwise exceed 255 sectors. Limiting the FAT to 255 sectors requires doubling the cluster size from 2KB to 4KB when the partition exceeds 133.7MB, and from 4KB to 8KB at 267.4MB. Allowing the FAT to grow to 256 sectors moves the boundary points to 134.2MB and 268.4MB, respectively. The small difference hardly justifies upsetting a widely used data structure.

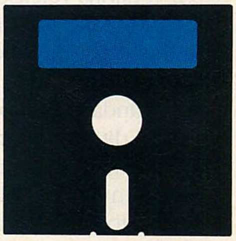
In DOS 3.31, Compaq uses both methods to maintain compatibility with the old data structure. This version usually formats a disk with a cluster size that keeps the number of clusters below 33,000, so the FAT occupies fewer than 130 sectors. But, DOS 3.31 can still use a DOS 4.0*x* partition where the FAT is 256 sectors long—it inserts a zero into the FAT length byte at offset 0FH of the disk parameter block. OS/2 1.1 also uses zero to represent a length of 256 sectors, but allows the FAT to grow to maximum size, if necessary, to minimize cluster size.

The differences in the parameter block formats do not prevent compatibility of large partitions across the various operating systems because the parameter block is constructed *in memory* by each system at boot-up. The source of the parameters is the BIOS parameter block (BPB) recorded in the partition boot record on disk; there, all versions since DOS 2.0 record information in the same format. Specifically, the number of sectors in the FAT is recorded in a 16-bit word.

Programs that need to process the disk parameters and work with both DOS 3.*x* and 4.0*x* have two choices. One is to go directly to the boot record for the information. This, however, requires an absolute disk read, which requires a different calling sequence in small and large partitions. (For more information, see the previously mentioned DOS article.) The second choice is to convert the version-specific information returned by function 32H into a common format. This is the method illustrated by the code fragment DPARMS.ASM (see listing 1). This is not a complete program; you must incorporate it into your own program before assembling it.

The data structure for holding the disk parameter block is defined in DOS 4.0*x* format, with a length of 33 bytes. After calling function 32H, the program moves 33 bytes from the DOS data area at DS:BX to the structure in the local data segment. The program then tests the DOS version; if the major version number is greater than 4, but less than 10 (the number returned in the DOS compatibility box of OS/2), the parameter block is only 32 bytes long. The program extends the block to 33 bytes by moving the second 16 bytes one byte up in memory and inserting a zero at offset 10H. If the word at offset 0FH is zero, it is changed to 256. This converts the parameter block from 3.*x* format to 4.0*x*; subsequent code can use the parameters with no further tests of the DOS version.

As written, this code assumes that subsequent DOS versions will use the new format, while the real mode of future OS/2 versions will use the old. If not, the code will need modification to reflect the actual state of affairs. As with all undocumented features, the solution given here is for current versions only; there are no guarantees that this will work in the future.



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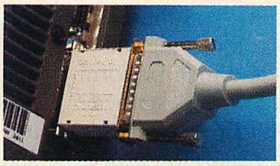

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2 UPDATE ON DUAL-BOOT

Although IBM chose not to incorporate dual-boot capability into any of the OS/2 versions released so far, the company did make it easier for users to add this capability themselves. In the versions that include Presentation Manager (Standard Edition 1.1 and Extended Edition 1.1), the names of the two system files are no longer the same as in DOS; they have been changed to OS2LDR and OS2KRNL (with no extensions). Therefore, the OS/2 system files can coexist with the DOS system files (IBMBIO.COM and IBMDOS.COM) without needing the patches described in the first four steps of the dual-boot installation procedure presented in September 1988 Tech Notebook (p. 137). In order to keep the length of the initial system file name unchanged, you may want to name the customized dual-boot loader ASKSYS instead of ASKSYS.COM.

In all other particulars, the dual-boot installation proceeds as described. Unfortunately, retaining the dual-boot capability when updating to a new version of OS/2 is difficult—you must first install the new version following the vendor's instructions and then perform the dual-boot installation as described in the September 1988 Tech Notebook.

One change that makes the procedure somewhat easier is the cleaner directory structure resulting from the automated installation of OS/2 1.1. The root directory contains about 20 files on a PS/2 system and only a dozen on an AT-bus machine (compared with more than 50 with version 1.0). The smaller size of the root directory makes it easier to keep track of the files required by both OS/2 and DOS.

In OS/2 version 1.1, the root directory contains only those device drivers that are essential during the initial phases of system initialization, before support of the tree-structured directory system becomes operational. Furthermore, only one set of drivers, appropriate to the target system, is installed. Version 1.0, on the other hand, installed drivers for both PS/2 and AT-class machines, even though one set was never used. All other files—including the drivers installed with DEVICE statements, the dynamic link libraries, the device code pages, and the message files—are placed in subdirectories C:\OS2, C:\OS2\SYSTEM, and C:\OS2\DLL.

For the most part, you can distribute files among these directories as you see fit, as long as the appropriate entries in the CONFIG.OS2 file reflect the actual locations of the various components. The OS/2 FORMAT command no longer supports the /S option (the installation procedure is the only way to create a bootable disk), so this command no longer needs a file that lists the locations of the system files to be placed on the target disk.

Updating the DOS version on a dual-boot system is normally a straightforward process—simply boot the system with the new DOS version from a diskette, run the SYS command on the hard disk, and proceed with the subsequent steps described in the September Tech Notebook. DOS 4.0*x*, however, provides an automated procedure that not only updates the hidden files and the boot record, but installs the shell program and replaces all external command files and device drivers.

This installation program replaces the OS/2 version of COUNTRY.SYS in the root directory and all copies of COMMAND.COM anywhere on the target disk, including the one used in the DOS compatibility box of OS/2. The lack of a protected-mode COUNTRY.SYS driver causes OS/2 to hang when the machine is booted. To restore the health of the OS/2 system after updating to DOS 4.0*x*, copy COUNTRY.SYS and COMMAND.COM from your original OS/2 distribution disks. Version 1.0 of both the Standard Edition and Extended Edition place COUNTRY.SYS in the root directory of the boot drive; version 1.1 puts it into C:\OS2\SYSTEM. You do not need the OS/2 version of the COMMAND.COM file if you disable the real-mode session by specifying PROTECTONLY=YES in your CONFIG.OS2 file.

3 COMPAQ DUAL-BOOT PROBLEMS

As many readers have pointed out, the dual-boot procedure does not work with Compaq's OS/2 Standard Edition 1.0. Although the system works fine when booted into OS/2, the diskette drives become inoperative in DOS—every access results in general failure messages.

The reason for this lies in Compaq's OS/2 boot record in a code sequence near the beginning of the record. In my copy of Compaq's OS/2, this sequence begins at offset 56H of the boot record (156H when viewed with DOS DEBUG or SYMDEB). This location is not guaranteed, so identify the code by content, not by address. The sequence is similar to:

```
PUSH    DS
XOR     BX,BX
MOV     ES,BX
MOV     DI,7C2B
LDS     SI,ES:[0078]
MOV     CX,000B
CLD
REPZ
MOVSB
MOV     Word Ptr ES:[0078],002B
MOV     ES:[007A],CS
POP     DS
```

The sequence of instructions copies the diskette parameters into the boot record and repoints the INT 1EH vector to the new location. Subsequently, the boot code modifies certain parameter values to facilitate diskette access when booting from a diskette. So, what is this code doing in a hard-disk boot record? Instead of creating an appropriate boot record for the hard disk, Compaq's OS/2 installation modifies a copy of the diskette boot code.

When booting OS/2, the left-over code that repoints INT 1EH does no harm because OS/2 ignores whatever it finds in that vector and repoints it to a newly created diskette parameter table. DOS, on the other hand, establishes its parameter table by copying and modifying the original one pointed to by the INT 1EH vector (the power-on procedure initializes it to a table in ROM). When DOS is started by the dual-boot process, the vector points to a location that now contains the DOS boot code instead of a parameter table. As a result, DOS constructs a table of invalid diskette parameters that causes the apparent drive failures.

The solution is to disable the code sequence that repoints the INT 1EH vector. This must be done in the same boot record that looks for the ASKSYS program. At the location of the PUSH DS (most likely offset 156H, if you are using DEBUG), assemble a jump to the location after the POP DS (offset 176H). Complete the modification of the boot record by inserting ASKSYS in place of IBMBIO or OS2LDR.

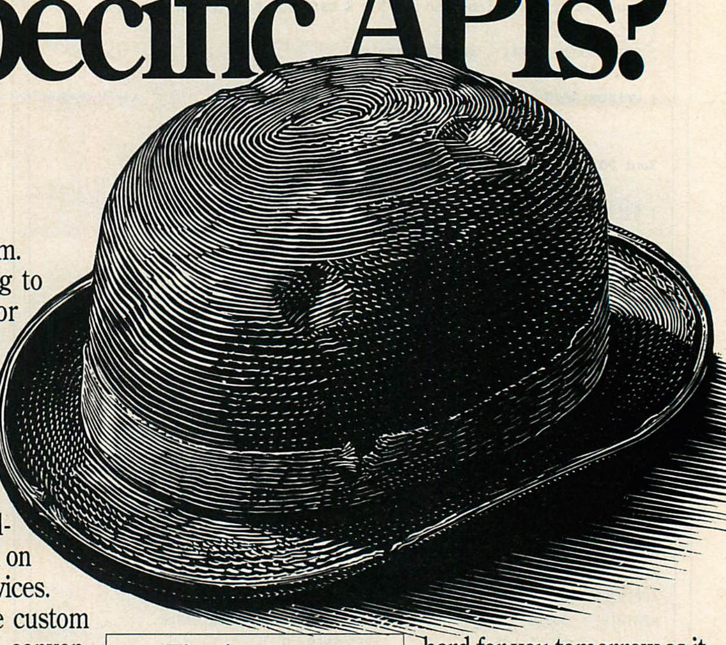
Apply this patch with caution. Do not blindly patch at a fixed location, but make sure you thoroughly understand the purpose of the code you are disabling. In subsequent versions of OS/2, Compaq may move this code, or, as it should have done in the first place, remove it entirely.

LISTING 1: DPARMS.ASM

```
; Sample code to get DOS disk parameter block, using INT 21h AH=32h
; Table is 32 bytes long for DOS 3.x & OS/2 DOS Box, 33 for DOS 4.0x
;
; CODE FRAGMENT ONLY, NOT EXECUTABLE
;
; Written by Ted Mirecki


%out DO NOT ASSEMBLE - NON-EXECUTABLE CODE FRAGMENT

; Define 33-byte parameter structure for DOS 4.0x

PARMBLOK  STRUC
DRIVEID   DB      ?                ;0 = A, 1 = B, ETC.
UNITNUM   DB      ?                ;UNIT NO. WITHIN DEVICE DRIVER
SECLEN    DW      ?                ;BYTES PER SECTOR
CLUSIZ_1  DB      ?                ;SECTORS/CLUSTER - 1
SHIFT     DB      ?                ;SHIFT COUNT OF SECS/CLUSTER
FAT1      DW      ?                ;FIRST SECTOR OF FAT?
NFATS     DB      ?                ;NO. OF FAT COPIES?
NROOT     DW      ?                ;ENTRIES IN ROOT DIR
DATA1     DW      ?                ;FIRST DATA SECTOR
NCLUS     DW      ?                ;HIGHEST CLUSTER NUMBER
FATSECS   DW      ?                ;SECTORS PER FAT COPY
ROOT1     DW      ?                ;1ST ROOT DIR SECTOR
DEVPTR    DD      ?                ;FAR PTR TO DEVICE DRIVER
MEDIAID   DB      ?                ;MEDIA ID BYTE
ACCESSED  DB      ?                ;0 IF DISK ACCESSED, ELSE FF
NEXTPTR   DD      ?                ;FAR PTR TO NEXT DISK TABLE
          DW      ?                ;RESERVED, 0
          DB      ?                ;RESERVED, FF
BLOKEND   DB      ?                ;RESERVED, FF
PARMBLOK  ENDS


          .MODEL SMALL
          .DATA
DPARMS    PARMBLOK <>


          .CODE
          MOV     AX,DS            ;POINT ES TO DATA SEGMENT
          MOV     ES,AX
          PUSH    AX               ;SAVE DATA SEGMENT
          MOV     DX,DRIVNUM       ;0 FOR DEFAULT, 1 FOR A, ETC.
          MOV     AH,32h           ;GET DISK PARAMETER TABLE
          INT     21h
          LEA     DI,DPARMS        ;ES:DI POINTS TO LOCAL TABLE
          MOV     SI,BX            ;DS:SI POINTS TO DOS TABLE
          MOV     CX,TYPE DPARMS   ;LENGTH OF TABLE
          REP     MOVSB            ;MOVE TABLE TO LOCAL DATA AREA
          POP     DS

          MOV     AH,30h           ;GET DOS VERSION
          INT     21h
          CMP     AL,10            ;IS IT OS/2 REAL MODE?
          JAE     DOS3X            ;IF YES, TREAT LIKE DOS 3.x
          CMP     AL,4             ;IS IT DOS 4.0 OR ABOVE?
          JAE     CONTINUE         ;IF YES, TABLE IS ALREADY 33 BYTES
                                   ;FOR DOS 3.X, EXPAND TABLE

DOS3X:    LEA     DI,DPARMS.BLOKEND    ;ES:DI->END OF V4.0 TABLE
          LEA     SI,[DI-1]            ;DS:SI->END OF V3.X TABLE
          MOV     CX,BLOKEND-ROOT1+1   ;LENGTH TO MOVE
          STD                          ;GO BACKWARDS
          REP     MOVSB                ;EXPAND TABLE BY 1 BYTE
          CLD                          ;RESTORE DIRECTION
          MOV     BYTE PTR DPARMS.FATSECS+1,0   ;CONVERT BYTE TO WORD
          CMP     DPARMS.FATSECS,0     ;IF FAT LENGTH IS ZERO...
          JNE     CONTINUE
          MOV     DPARMS.FATSECS,256   ;...MAKE IT 256

CONTINUE:
```

Listings can be downloaded using PCTECHline, 301/740-8383. Parameters: 2400/1200/300 bps, no parity, 8 data bits, 1 stop bit.

Whatever happened to emulator-specific APIs?



Linking PCs to mainframes may be old hat. But to do the job properly, you need to build on top of your emulator, creating a custom application that's both bullet-proof and idiot-proof.

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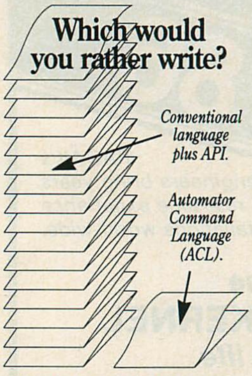

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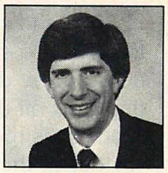


Who You Callin' a User?

The territorial boundaries between users and developers are blurred. Perhaps systems should simply be designed to deal with people.

Achtung! So begins a humorous warning (author unknown) posted in many computer installations. *"Alles Touristen und Non-Technizien Lookenspeepers! Der Machinen-Control ist Nicht fur Gefingerpoken und Mittengrabben! Oderwise, ist Ezie Schnappen der Springenwerk, Blowenfusen, und Poppencorken mit Spritzensparken! Das Rubbernecken Siteseeren Keepen das Kottenpicken Hands in das Pockets! Relaxen und Watchen das Blinkenlights!"*

We must, after all, keep users in their place. But a funny thing happened on the way to today: users started to act like developers, and developers, not to be outdone, started to act like users. Today it's like gang warfare; each group believes that it is distinct from the other, although to the objective observer the differences are mostly a matter of labeling.

I have heard "users" complain about the need for a decent macro editor for WordPerfect. They must have been doing some pretty serious work to require such a facility; in fact, I have seen one system built in WordPerfect 4.2 that performed in a way you would normally expect from a full-blown, free-text database. Furthermore, this system was built by someone who characterized himself as a user, with "no time to do any programming." You could have fooled me.

Conversely, have you noticed the way "developers" have taken to moaning about the brain-damaged installation routine supplied with their latest compiler? What happened to the days when a developer would unassemble the code, identify the problem, and patch the distribution files without a moment's pause? Then again, when did compiler manufacturers decide that their customers preferred monolithic installation routines—.EXE files, rather than .BAT files that could be read before they were let loose?

When a so-called convenience feature like an .EXE install utility goes wrong, the results can be disastrous. A colleague recently told me of his experience with an Ada compiler that got confused in the course of its own installation, leaving the target disk with literally hundreds of cross-linked files. A format and restore was the only workable solution.

Unsolicited changes to CONFIG and AUTOEXEC files are petty annoyances compared with such wholesale havoc, but can waste a great deal of time—and, interestingly enough, "users" are doing their share of complaining about such situations. If you ask me, they sure quack like systems integrators, even if they themselves are their only customers.

The development community may be underestimating these people. Their needs are very different from those of the user of yesteryear, and their level of knowledge reflects it. They have no choice; today's systems demand it.

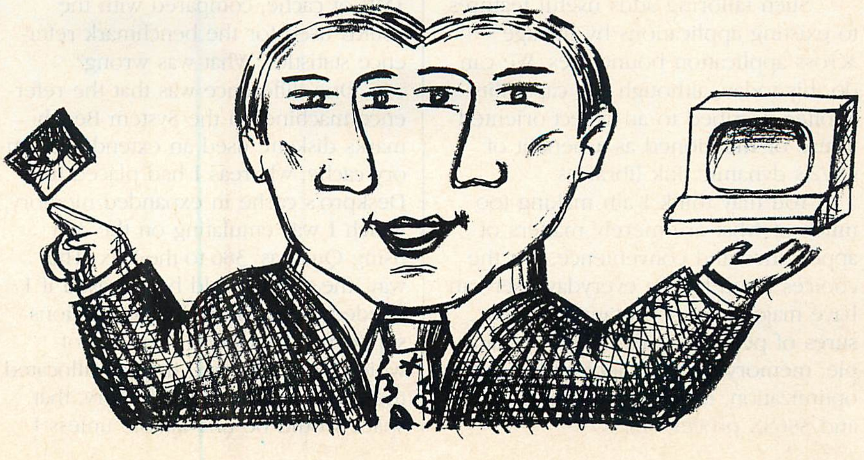
WORKSTATIONS FOR ALL

This change in perspective is reflected in the evolving definition of a workstation. About three years ago, someone at a meeting of the Personal Computer Professionals Association asked if anyone could define the difference between a workstation and a PC. "A workstation is a PC with a big screen and a price tag over $10,000," I replied.

I was kidding to some extent, but I wanted to make the point that many mainframe developers have realized major gains in productivity by moving from a dumb terminal to an ordinary monochrome-screen PC as their primary development platform. They get workstation-class benefits from these machines. What does that say about the definition of *workstation*?

Consider this case in point: Loren Industries in Hollywood, Florida, has done extensive in-house systems development and integration to support its work in precious-metals refining and jewelry design and manufacturing. Until quite recently, however, the company's two senior managers had never had a computer or terminal in their offices. Now, I was told, they both have "386 workstations" running Quarterdeck's DESQview. They run financial and groupware applications as a coordinated system, which has become a key part of their daily routine.

This started me thinking that perhaps there is a meaningful distinction between a PC and a workstation, apart from spurious issues of big bit-mapped



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displays and sluggish graphics interfaces. The core of that difference is that a PC can be defined as an appliance that runs off-the-shelf applications, essentially as they come out of the box (or out of the compiler in the case of custom vertical software). By contrast, a workstation is a platform that links and enhances those applications to create a powerful problem-solving environment. Every environment is unique, and in that sense every user becomes his or her own developer.

Almost every class of commercial software is moving toward customization. Version III of Ashton-Tate's Framework now lets you build a personalized desktop. It remembers, for example, your preferences for position, size, and organization (by name or by date) of the cabinet frames that it uses to provide a view of the DOS file system. It lets you specify on-screen colors (foreground and background) for 14 different categories; for example, I use yellow on gray for status lines and white on black for my work. The point is that you have a choice.

When every application offers these choices, the effect is cumulative. Borland's Turbo Prolog offers customization, and I have made similar choices there (yellow for status, white for work space). These conventions let me use consistent color cues across applications, reducing mental friction as I move from one task to another.

A tool such as DESQview opens up many more opportunities for construction of a workstation platform. One of my DESQview macros couples my terminal emulator to a text-edit session, allowing me to take snapshots of the terminal screen. This lets me save material from the session *after* seeing it rather than capturing it to a file *before* I have seen the information to be saved (an annoying restriction of many communications programs).

Such tailoring adds useful features to existing applications by linkage across application boundaries. We can do this today, although the capability is often ascribed to an object-oriented future or mentioned as a benefit of OS/2's dynamic link libraries.

You may think I am making too much of what are merely matters of appearance and convenience, but the choices faced by the everyday user can have major impact on tangible measures of performance. Take, for example, memory management and cache optimization, especially on the 80386 and 386SX processors.

WHO TOOK MY SPEED?

I was feeling pretty sassy after I installed Golden Bow's Vcache (disk cache) utility on a client's Compaq Deskpro 386. Edit, compile, debug, repeat; the disk access light barely flickered, compared with the bright green glare of constant disk activity before I put the cache in place.

Everything came up as quickly as if it were on a RAM disk, but with none of the worry about what would happen if the system hung; at the absolute worst, only the last two seconds of work would be left unsaved.

Particularly pleasing was the impact of the cache on Borland's word processor, Sprint, which does print previews by saving the file and running it through the formatter to the screen. When I leave a formatting session with Sprint, I often see cache "hit" statistics showing only three or four percent of the disk read requests actually going to the disk. This must improve disk life, as well as performance.

Most machines, even DOS-based, can achieve their full potential only with a substantial amount of exploratory optimization.

I was surprised, therefore, when I ran the *PC Tech Journal* System Benchmarks and found disk performance on my client's Deskpro 386 to be substantially slower than that of an ordinary PC/AT 339, the reference machine for the HLDISK benchmark (see "High-level Measurements," Kent Quirk, September 1988, p. 54). I had allocated 1MB of cache, compared with the 256KB used for the benchmark reference statistics. What was wrong?

One difference was that the reference machine on the System Benchmarks diskette used an extended memory cache, whereas I had placed the Deskpro's cache in expanded memory, which I was emulating on the 386 using Qualitas' 386-to-the-Max. This way, the cache could be released if I needed the memory for applications supporting expanded memory, of which I have several. If I had allocated the cache in extended memory, that space would be unavailable unless I rebooted with a modified CONFIG.SYS file. Could the overhead of expanded memory page-swaps be that great?

You bet it could. When I went from a 1,024KB cache in expanded memory to a 520KB cache in extended memory, overall disk performance increased by a factor of more than 4.6.

Even with this considerable improvement, the client's Deskpro still fell short of the System Benchmarks reference figures. What could account for the difference?

The only remaining discrepancy was the reference system's use of 25 DOS buffers. I had used only five, based on a study that concluded DOS's primitive algorithm was far worse than most cache programs. The study advised that performance in a system with a disk cache would generally be improved by minimizing the number of buffers managed by DOS to 3 to 5.

Surprise, surprise! When I went to 25 DOS buffers, disk performance on my client's machine improved by another factor of 1.7. Combined with the shift from expanded to extended memory, this brought performance on the HLDISK benchmark to almost *eight times* the speed of my initial (already cached) configuration.

This left one more issue to address. HLDISK uses a database of 500 records, for which it generates an index and various reports. Because I wanted to keep a reasonable pool of expanded memory available for applications that require it, I was inclined to use only about half a megabyte of extended memory rather than the full megabyte of (releasable) expanded memory that I had previously employed. What would happen with a larger database that might cause thrashing in the smaller cache?

It is no surprise that a larger database offset the higher speed of extended memory cache. When I told HLDISK to use 5,000 records, ten times the default, the expanded-memory cache became 2-percent faster than an extended-memory cache of half the size. The statistics maintained by Vcache were consistent with this result: the system was going to disk for 21 percent of its read operations with the smaller cache, compared with only 5 percent with the larger one.

THE CAN OF WORMS IS OPEN

What this whole cache exercise shows is that most machines, even DOS-based, can achieve their full potential only with a substantial amount of explora-

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tory optimization. This is why I laugh when people say that an engineering workstation like a Sun or an RT PC is too much for the average user to deal with, or when they say that Unix requires too much tuning to be a serious competitor for DOS.

Yes, setting up Unix can be a pain, but out-of-the-box systems like SunView (for the Sun 386i) and IBM's AIX (for the RT and soon for the PS/2) are improving that aspect considerably.

No reliable rules of thumb can tell you how to optimize your system's performance; making the system fly requires a balancing act in the context of the user's actual tasks. For the disk subsystem alone, you must choose from three different types of memory—conventional, expanded, and extended—combined with a choice between internal (DOS buffers) and external (cache utility) management. This confusing set of options sounds at least as bad as the once-forbidding Unix question, "How much swap space?"

From colors to caches, these and other choices are being left to the user—unless, of course, you wish to contemplate the option of returning to multiuser systems. These are subject to centralized administration by professionals, who at least in theory are willing and able to make it their job to match capabilities against needs; on the other hand, multiuser systems have gotten to be quite expensive.

The cost of adding multiuser capability to a 386 machine—by the time you add serial ports, terminals, and the multiuser operating system itself—rivals the cost of providing those users with stand-alone XT- or even AT-class computers. Multiuser systems are put into service for reasons of security, data sharing, access to mainframe-class storage and peripherals, or perhaps, for access to mainframe applications that no one is willing to recode.

When single-user machines are the dominant platform, every user becomes a systems integrator and to some extent a developer. The flip side of this is that desktop systems have become more complex than the mind of any one person can comprehend, so the developer is necessarily a user of the technologies more than one or two levels down.

This issue of multiple levels arose in a recent debate that took place on the Advanced Research Projects Agency network (ARPAnet). The discussion concerned the need, or lack thereof, for proficiency in assembly language. "I believe it is important to learn assembly language for *some* computer," wrote one participant, "because that is how you learn how computers *really* work." Replied another, "Do you think it is important to understand how transistors work as well?"

A third contributor to the debate wrote, "I have to agree with [the first contributor] to some extent. It is often useful to understand how the next lowest level works." He continued,

> When I was designing logic, knowing how the individual transistors worked sometimes got me out of trouble. When I was writing assembly, it was useful to know about machine code, and how the processor actually executed the instruction. When I write "High Level" C, knowing how the underlying assembly works helps me deduce the problem at times. I can sometimes examine the assembly output and debug faster than looking at the C source. And now, when I program in C++, I occasionally benefit from looking at the C output. I think that they call this "having a foundation in the basics."

But how do you decide what is "basic"? I cringe inside whenever I hear myself telling a user, "You

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shouldn't have to know that." Yes, but the problem is that because they don't know that, they have to wait for me to solve a problem that they would rather solve for themselves. Unless you can anticipate their every need, you need to do everything possible to let users safely exercise that option.

SUGGESTIONS FROM STANLEY

In 1976, Canada sponsored a meeting in Quebec at the Stanley House, pooling the talents of computer experts and philosophers to address the role of ethics in computer-based systems. Some of their recommendations offer precisely the perspective we need as we address the new hybrid population of user/developers.

"A system should assist participants and users and not manipulate them," reads one Stanley recommendation. Absolutely. Anytime the system asks me what I want to do, it should offer choices; systems designers should take pains to make the consequences of those choices as clear as possible.

This does not mean you should clutter the screen with trivial information, but it does mean you should provide the user ample opportunity to explore the available options. The help utility in POLYTRON's PolyShell is an excellent example. PolyShell provides an alternative to the COMMAND.COM shell, with commands and utilities similar to those in the Unix environment, as well as the ability to use DOS features. Unlike DOS, PolyShell understands that no one can be expected to memorize the entire command vocabulary. At any point, the user faced with a command prompt can press the Shift and down arrow keys to access a menu of top-level categories: Files, Directories, Disks, Shell, and Other.

Selecting one of these and again pressing the Shift and down arrow keys displays the corresponding subchoices. If you select Files, the next level down offers Modify, Examine, Compare, Print, and so on. This progression continues, if desired, all the way down to the options on the individual commands.

This help does not come free. The help files for PolyShell occupy almost a quarter-megabyte of disk space. They sure do beat carrying around the manual, though, when, for example, you want to use the **du** command to find out the names, sizes, and total space occupied by files in the help directory (**du −a \usr\help** does the trick). Even more elaborate are the help facilities of the Sun 386i. They take advantage of the multiwindowed, graphically oriented SunView environment and use many of the linkage capabilities loosely referred to as hypertext.

Two more of the Stanley House recommendations are appropriate here. The first reads, "A system should recognize that special conditions might occur that could require special actions." This is particularly true, notes the second recommendation, in the correction of foreseeable errors. These principles, scrupulously observed, could do much to reduce the infuriation factor in dealing with today's one-track-mind environments.

Like a sign on an exit ramp that reads, "This Way to Return to Freeway," computer environments must take the trouble to imagine typical errors and allow for their graceful correction. In a world where we are all independent developers, and at the same time users, this kind of courtesy should be one of our most important goals.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

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Cocaine lies.

After nearly a decade of being America's glamour drug, researchers are starting to uncover the truth about cocaine.

It's emerging as a very dangerous substance.

No one thinks the things described here will ever happen to them. But you can never be certain. Whenever and however you use cocaine, you're playing Russian roulette.

You can't get addicted to cocaine.

Cocaine was once thought to be non-addictive, because users don't have the severe *physical* withdrawal symptoms of heroin—delirium, muscle-cramps, and convulsions.

However, cocaine is intensely addicting *psychologically.*

In animal studies, monkeys with unlimited access to cocaine self-administer until they die. One monkey pressed a bar 12,800 times to obtain a single dose of cocaine. Rhesus monkeys won't smoke tobacco or marijuana, but 100% will smoke cocaine, preferring it to sex and to food—even when starving.

Like monkey, like man.

If you take cocaine, you run a 10% chance of addiction. The risk is higher the younger you are, and may be as high as 50% for those who smoke cocaine. (Some crack users say they felt addicted from the *first time* they smoked.)

When you're addicted, all you think about is getting and using cocaine. Family, friends, job, home, possessions, and health become unimportant.

Because cocaine is expensive, you end up doing what all addicts do. You steal, cheat, lie, deal, sell anything and everything, including yourself. All the while you risk imprisonment. Because, never forget, cocaine is illegal.

There's no way to tell who'll become addicted. But one thing is certain.

No one who is an addict, set out to become one.

C'mon, just once can't hurt you.

Cocaine hits your heart before it hits your head. Your pulse rate rockets and your blood pressure soars. Even if you're only 15, you become a prime candidate for a heart attack, a stroke, or an epileptic-type fit.

In the brain, cocaine mainly affects a primitive part where the emotions are seated. Unfortunately, this part of the brain also controls your heart and lungs.

A big hit or a cumulative overdose may interrupt the electrical signal to your heart and lungs. They simply stop. That's how basketball player Len Bias died.

If you're unlucky the first time you do coke, your body will lack a chemical that breaks down the drug. *In which case,* you'll be a first time O.D. Two lines will kill you.

Sex with coke is amazing.

Cocaine's powers as a sexual stimulant have never been proved or disproved. However, the evidence seems to suggest that the drug's reputation alone serves to heighten sexual feelings. (The same thing happens in Africa, where natives swear by powdered rhinoceros horn as an aphrodisiac.)

What is certain is that continued use of cocaine leads to impotence and finally complete loss of interest in sex.

It'll make you feel great.

Cocaine makes you feel like a new man, the joke goes. The only trouble is, the first thing the new man wants is more cocaine.

It's true. After the high wears off, you may feel a little anxious, irritable, or depressed. You've got the coke blues. But fortunately, they're easy to fix, with a few more lines or another hit on the pipe.

Of course, sooner or later you have to stop. Then—for days at a time—you may feel lethargic, depressed, even suicidal.

Says Dr. Arnold Washton, one of the country's leading cocaine experts: "It's impossible for the nonuser to imagine the deep, vicious depression that a cocaine addict suffers from."

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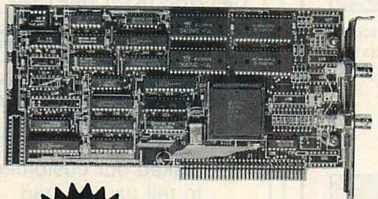

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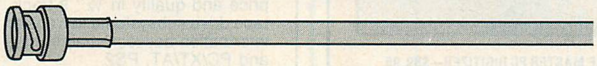

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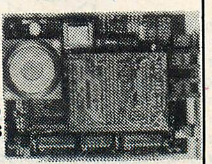

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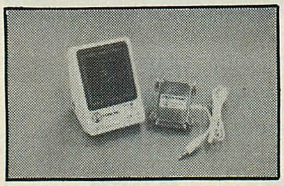

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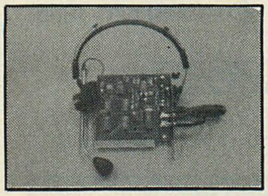

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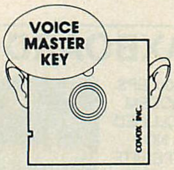

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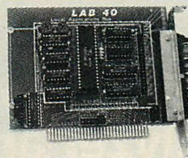

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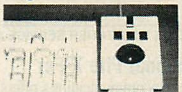

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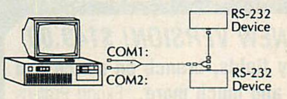

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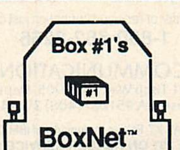

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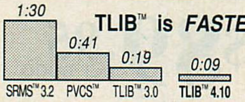

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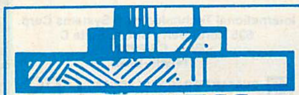

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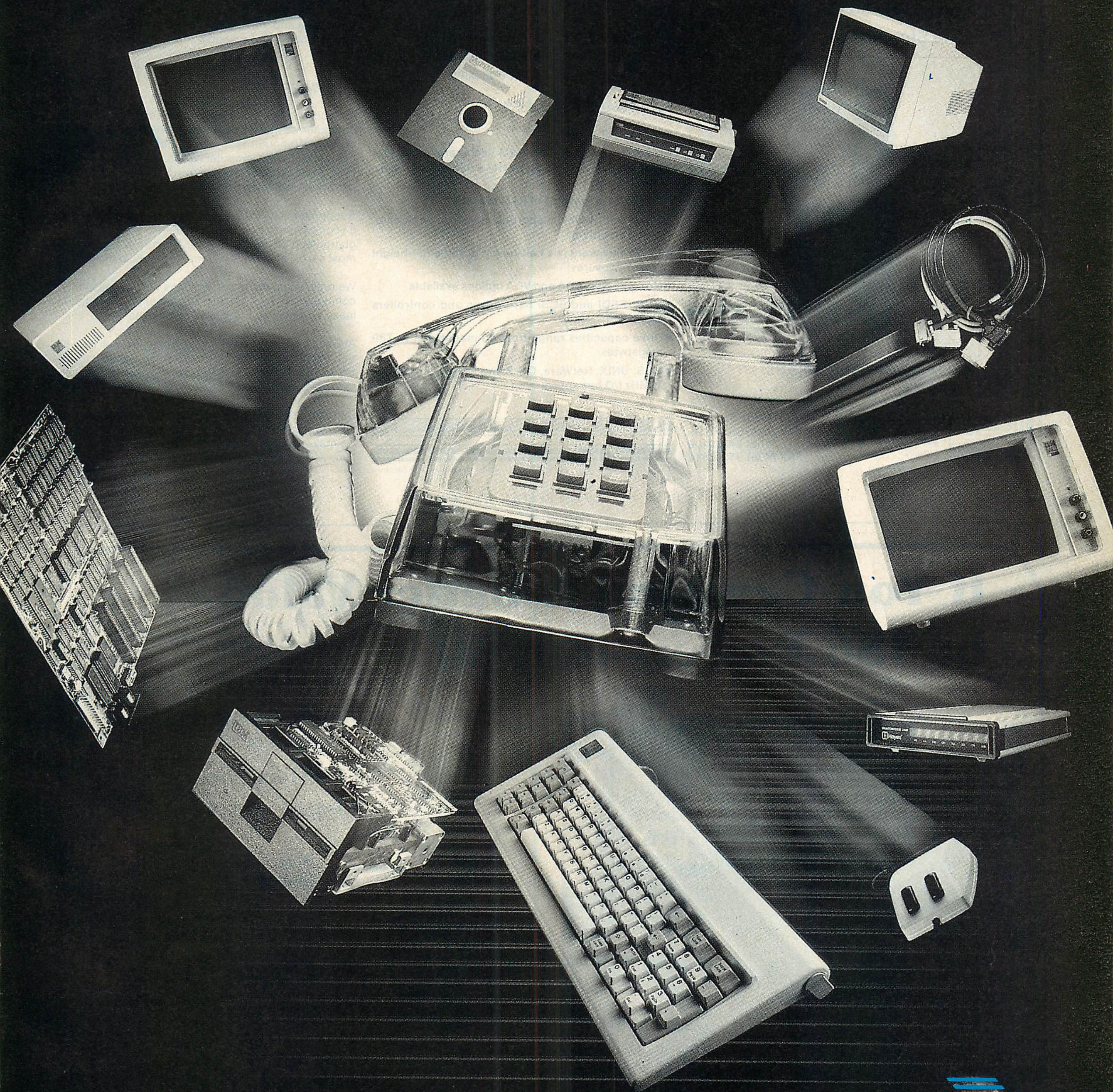

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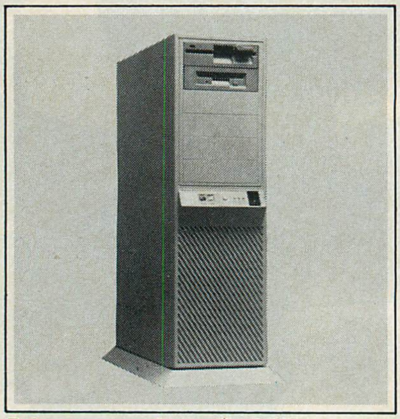

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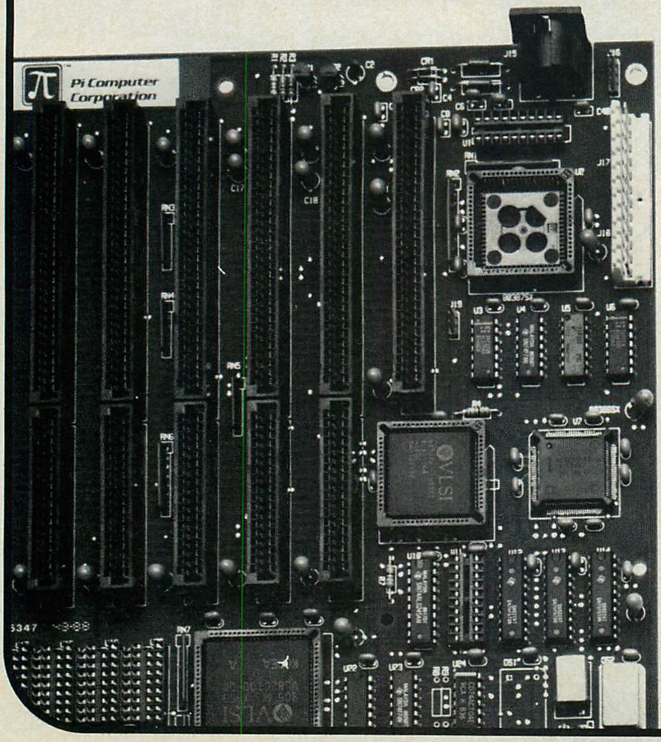

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High C 386	895	799
Microport Sys. V/386 (Comp.)	899	799
Microsoft Windows/386	195	130
NDP C-386	595	529
NDP FORTRAN-386	595	529
SCO 386 XENIX Sys. V (Comp.)	1495	1195
VM/386	245	199

ASSEMBLY LANGUAGE

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asmLIB	149	125
MS Macro Assembler	150	99
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Visible Computer: 8088	80	72
Visible Computer: 80286	100	89

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Finally! XGRAF	99	90
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Turbo C 2.0 Professional	250	175
Zortech C + +	100	90

C LIBRARIES/UTILITIES

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C TOOLS PLUS/5.0	129	95
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Essential Communications	185	125
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Greenleaf Business Mathlib	325	229
Greenleaf Comm Library	229	169
Greenleaf Functions	209	155
Greenleaf SuperFunctions	265	189
PC-lint	139	101
PforCe	395	215
/*resident C*/	99	79
w/ source code	198	159
TimeSlicer	295	279
w/ source code	1000	899
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MetaWINDOW/PLUS	275	232
TurboHALO	100	80

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Greenleaf MakeForm	125	90
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JAM	750	684
PANEL Plus	495	395
PANEL/QC or /TC	129	99
SoftCode	79	70
Vitamin C	225	162
VCScreen	149	109
Windows for Data	295	259
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Genifer	395	259
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	LIST	OURS
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SPF/PC	245	185
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w/ source code	90	79
Topaz	50	45
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Turbo Geometry Library	150	135
TurboMAGIC	199	179
Turbo-Plus 5.0	100	80
Turbo POWER TOOLS PLUS	129	95
Turbo Professional	125	99

TRANSLATORS

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Bas_C (Commercial)	375	323
Bas_Pas (Economy)	149	129
Bas_Pas (Commercial)	280	242
BASTOC	495	399
dBx TRANSLATOR	550	469

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Opt-Tech Sort	149	105
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Pfinish	395	215
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PROFESSIONAL VIEWPOINT

Readers choose their most valuable computer products to receive PC Tech Journal's Professional Solutions Award.

Computer products that solve everyday problems are priceless to developers and integrators. *PC Tech Journal* asked its readers to choose their most valuable products in six categories—development tools, data managers, computer systems, communications, multitasking operating environments, and add-in boards. Based on our readers' most compelling reasons for their selections, we chose 27 nominees to receive *PC Tech Journal*'s Professional Solutions Award.

The recipients of this award were chosen because they make our readers' lives easier, not necessarily because they were the best-selling. (For a description of the awards process, see Systems Perspective, this issue p. 9.)

DEVELOPMENT TOOLS

One of the development tools honored is Clarion Software's **Clarion Professional Developer**, which generates complete applications. For B. A. Swisshelm, president of DataCare in Nashville, Tennessee, "Clarion packs a double whammy. I quickly produce quality applications with no fees for user copies."

Randy Goodhew, a partner in Professional Technologies Consultants, a Covington, Kentucky, company that develops database applications, attests that "Clarion has tripled my productivity and income."

Microsoft C 5.1 is indispensable for lengthy projects, say a number of readers. Kevin Boutote, a consultant in New York City, is good-natured about Microsoft C's dependability in the face of human frailty. Boutote says, "Each time I think I've discovered a bug, it turns out to be mine!"

BRIEF, the program editor from Solution Systems, is recognized for flexibility. "I can make it smarter than it is, to work differently for different needs," says Craig Given, a consultant with Montague Independent Computer Consulting in Chattanooga, Tennessee.

Borland International's **Turbo C** and **Turbo Pascal** are considered convenient and powerful edit-compile-link packages. David Ramger, systems engineer with Computer Task Group in Raleigh, North Carolina, believes they "are the new industry standard for integrated development."

Because development is not an isolated single-tool phenomenon, choosing an optimum hardware and software combination is tricky. A top-notch PC environment can lessen dependency on slow, expensive mainframes. Micro Focus Inc.'s **COBOL Workbench**, Gupta Technologies Inc.'s **SQLBase**, and Compaq Computer Corporation's **Deskpro 386/20** are a winning combination, says Jim Sutton, senior programmer/analyst with the Industrial Commission of Virginia in Richmond. "These products have allowed us to bring processing in-house from a shared mainframe to a PC LAN and save $20,000 per month."

DATA MANAGERS

Data managers that readers single out include Fox Software Inc.'s **FoxBASE** and Nantucket Corporation's **CLIPPER**. Both use the dBASE language but add features beyond dBASE III.

In a testimonial to FoxBASE, Dag Anderson, an applications developer in Manchester, New Hampshire, says "FoxBASE made bulky, multiuser dBASE code seven times faster."

CLIPPER receives raves, too. "It has the best handling of menus, arrays, error trapping, and debugging in dBASEland," says Hilton Barry, software consultant with Computer Applications in Lake View Terrace, California.

Revelation Technologies Inc.'s **Advanced Revelation**, noted for progressive tools and support of variable-length fields, is a reader choice for large databases. Bob Stolarz, president of PC Insights in Montclair, New Jersey, says, "Its combination of variable length and multivalued fields results in substantial disk-storage savings."

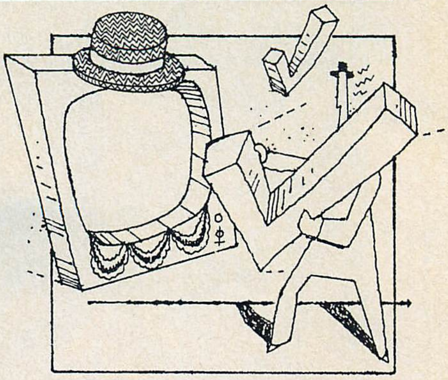
Borland International's **Paradox**, with its simplified Query-By-Example (QBE) facility, is selected for excellence in developing applications for novice users. "Paradox enabled me to develop an easy-to-use database for a user with no PC experience," says Timothy McTigue, who is MIS manager for Mangus/Catanzano Inc., in Pittsburgh, Pennsylvania.

Users need to know one data-management system and language to access data across multiple platforms. **ORACLE**, from Oracle Corporation, with its Structured Query Language (SQL)—now becoming standard among data managers—is a shot-in-the-arm for those with multiple operating systems requiring advanced data sharing.

"ORACLE's portability saved my life," says Brian Allan, director of technology for System 5 in Milwaukee, Wisconsin. "It ports to VMS, Unix, OS/2, and DOS."

COMPUTER SYSTEMS

In the hardware arena, IBM's **PS/2 Model 70**, part of the second wave of Micro Channel systems, is considered



the best PS/2 yet, according to some readers. "The PS/2 Model 70 is small, slick, and fast. It is technology at its best," says Alan Allen, director of software development at Mighty Byte Computer Inc., in Raleigh, North Carolina.

Many readers feel that Dell Computer Corporation's **Dell System 310**, a 20-MHz, 386-based machine, is a top-notch computer system. Alan Anderson of Anderson Consulting in San Diego, California, says, "The Dell System 310 equals power, quality, service, and support at a sensible price."

Compaq's **Portable 386**, is the only portable singled out. This 20-MHz machine is suited for the desktop as well as on-the-road use. John Schmitz, vice president of Information Resources Inc., in Waltham, Massachusetts, tempers his praise: "In spite of its bulk, I love my Compaq Portable 386. Now, to get it down to two pounds."

Finally, AST Research's **AST Premium/286**, which operates at 10 MHz with zero wait states, is the leading 80286-based machine, say some readers. Robert Venner, senior technical specialist at Transform Logic Corporation in Scottsdale, Arizona, is one Premium/286 advocate. He says, "It is compatible, reliable, and speedy."

COMMUNICATIONS

Readers stand by several products in the complex world of communication among micros, minis, and mainframes.

Datastorm Technologies Inc.'s PROCOMM PLUS stands out for accessing data from mainframes, minis, and bulletin boards. From its origins as a shareware package, it is now a viable commercial product.

"The 3270 emulation and overall ease of use of PROCOMM PLUS make it easier to support than other communications packages," says Matt Richards, computer resource manager at the University of Illinois College of Communications in Urbana.

Meridian Technology Inc.'s **Carbon Copy 5.0** and Norton-Lambert Corporation's **Close-Up** are valuable remote-communication packages for some readers. Allowing access and control of another machine, they support users without requiring on-site visits.

"Carbon Copy 5.0 has kept me from driving my life away for customer software updates and fixes," says Roy Wellborn, a systems programmer at Preferred Data Corporation in High Point, North Carolina.

As for Close-Up, David Roach of Roach Software Inc. in Scarborough, Ontario, Canada, says, "It provides fast support without leaving the office."

OPERATING ENVIRONMENTS

Operating environments that run multiple tasks simultaneously are productivity platforms for the future. Today, readers support tried-and-true products.

Quarterdeck Office Systems' **DESQview** is noted for its ability to sit down to tea with just about any other PC product, its flexible countenance, and its use of the 386 microprocessor. "I haven't found anything it won't run," says Harold Brown, a programmer at Specialized Data Systems in Nashville, Tennessee.

"DESQview's windows and keyboard macros let me structure work my own way," says Ken Hammond, a programmer/analyst with Crop-Hail Insurance in Overland Park, Kansas.

John W. Fowler, vice president of Global Solutions in Santa Monica, California, lauds DESQview because it "completes the 386 machine."

Unix, the veteran multitasking and multiuser environment receives accolades from some readers. "Unix with **DOS Merge 386** [from Microport Systems] averted installation of a LAN and saved thousands of dollars," says Fred Stanton, information center manager at Washington National Insurance Company in Evanston, Illinois.

PC Insights President Bob Stolarz says, "**QNX** [from Quantum Software Systems Ltd.] is Unix done right. It has the power and elegance of Unix without the overhead."

ADD-IN BOARDS

The most worthwhile add-in boards improve performance on both old and new PCs. Even fast 386 machines can benefit from an added kick.

For the PC/XT, which may not be as spritely as it once was, readers recommend Intel Corporation's **Inboard 386/PC**. "It turned my dinosaur Compaq portable into a screaming monster (for under $1,000)!" says Chris Armstrong, a programmer at United Systems Software in Mesa, Arizona.

Another add-in board selected for putting the bounce back into the step of the older PC is Quadram Corporation's **386XT**. Doug DeBono, owner of Systems Consulting in Minnetonka, Minnesota, says, "It adds three years to the life of my aging XT."

Newer Technology's **Dart** add-in board was chosen, too. "Dart, a RAM disk with its own CPU, doubles the speed of my 16-MHz 386 machine," says David Darnell, senior systems analyst at Southeastern Institute of Research Inc., in Richmond, Virginia.

If you are looking for a board to do a mundane or outrageous task, David Lanni, president of Creative Systems and Software Inc. in Stow, Ohio, recommends turning to **AST add-in boards**. "I can find an AST board for anything I need to do."

WINNING SOLUTIONS

These reader testimonials are an excellent measure of a product's real-world usefulness. The products were not chosen in a popularity contest, but because they contribute to productivity. From the experience of our readers, they represent what systems developers consider productive PC products.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** PC Magazine's award of technical excellence for ALR's FlexCache 25386 was awarded November 1988.*

Advanced Logic Research, Inc.

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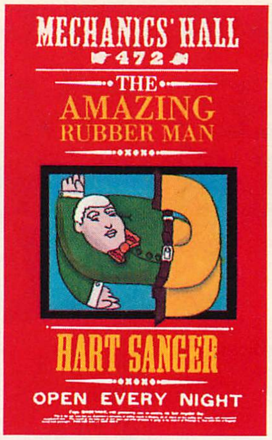

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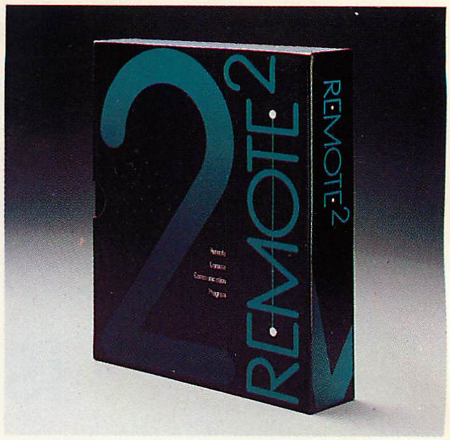

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